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EXPLORATION AND MINING IN BRITISH COLUMBIA - 1999

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COVER PHOTO...

Steve Robertson, project manager, overlooking drill hole 99-2 on the Silvertip property, 85 kilometres southwest of Watson Lake.

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PRINCE GEORGE
BRITISH COLUMBIA
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APRIL 2000

FOREWORD

The area of greatest exploration interest in 1999 was the East Kootenay region, where several companies searched for the elusive successor to the giant, and soon-to-be-exhausted Sullivan zinc-lead-silver deposit. Geological surveys and drilling programs conducted by Eagle Plains Resources Ltd., Billiton Exploration Canada Inc., Chapleau Resources Ltd., Rio Algom Exploration Inc. and Kennecott Canada Exploration Inc. on the North Findlay, South Findlay, Pakk, Pyramid Peak, Greenland Creek and other properties identified and tested new showings of sedex mineralization. In the north, an outstanding drill intersection by Peruvian Gold Ltd. and Imperial Metals Corp. on the Silvertip silver-lead-zinc manto prospect prompted reactivation of underground exploration. Two new volcanogenic massive sulphide discoveries sparked interest in the Cariboo district of central B.C. Barker Minerals Ltd. found a base metal sulphide lens in metamorphosed felsic volcanic rocks at Frank Creek, and the Lottie high grade float prospect was optioned from Eureka Resources Inc. by Hudson Bay Exploration and Development Co. Ltd. In the southern area of the province, at Cam Gloria and other properties, there was keen interest in intrusive-related gold deposits akin to the Pogo and Fort Knox deposits in Alaska.

Provincial exploration expenditures in 1999 were about $25 million and have been in decline since 1996. Exploration drilling, and the number of new mineral claims also declined in 1999 compared to 1998. In addition to the follow-up of encouraging intrusive-related gold, sedimentary and volcanogenic massive sulphide projects listed above, exploration in 2000 is also expected to focus on platinum group metals, oxide zinc deposits in southern B.C. and gold-silver deposits in the southern corner of the "Golden Triangle". The latter reflects acquisition of the Red Mountain gold prospect by Wheaton River Minerals Ltd. and the staking of numerous Eskay Creek targets in the Kitsault area. New discoveries by prospectors over the past several years, many assisted by the provincial government's Prospectors Assistance Program, have played an important role in attracting major and junior mining companies to invest in British Columbia.

Mineral production in 1999 was $2.6 billion, a decrease of 13% from 1998, as most producers of metals and coal continued to face difficult times. Metallurgical coal is British Columbia's most important mineral commodity and is mined at Line Creek, Fording River, Coal Mountain, Greenhills, Elkview, Quintette and Bullmoose, all located in the Rocky Mountains of southeast and northeast B.C. Thermal coal is produced at the Quinsam mine on Vancouver Island. Highland Valley Copper, B.C.'s largest metal mine, suffered a five month shutdown due to low copper prices and labour negotiations, but resumed full production in September. The Myra Falls polymetallic massive sulphide mine and the Endako molybdenum porphyry mine also sustained brief shutdowns. In contrast, the small but high-grade Eskay Creek gold-silver mine continued its strong performance, recording increased production and a higher reserve base than when the mine opened. Golden Bear, another small mine, had a robust performance as a seasonal heap-leach gold producer, due to uncommonly rapid leaching and high gold recovery. The Kemess porphyry gold-copper mine, in its second year of operation, came under new ownership and subsequent improvements in mining and milling are resulting in improved metal production. Two other comparatively new open-pit copper mines, Huckleberry and Mount Polley continued to maximize production. The Sullivan mine, the province's longest-lived operation, continued in full production but is nearing the end of its life. The Snip gold mine closed due to exhaustion of reserves. Due primarily to low commodity prices, there was little advancement toward production by new projects, such as the giant Prosperity porphyry gold-copper project, the large Tulsequah Chief polymetallic massive sulphide project, or the mid-size Telkwa thermal coal project. There were no new mines in 1999.

British Columbia produces a wide range of industrial minerals. In the southeast gypsum is produced at Elkhorn and Four J, magnesite at Mount Brussilof and silica from the Mount Moberly mine. Limestone is quarried at Gillies Bay and Blubber Bay on Texada Island, and also at Pavilion Lake and Harper Ranch in the southern Interior. The Parson barite mine closed in 1999 but Fireside, a small barite quarry in northern B.C., continued to produce on a seasonal basis. The highlight among new industrial mineral operations is development of the Ashcroft basalt quarry by IG Machine and Fibers Ltd., primarily for manufacture of roofing shingles. Other important projects include development of bentonite and zeolite deposits in the Ashcroft and Princeton areas, rehabilitation of the chrysotile asbestos mill at Cassiar, aggressive exploration of barite and gypsum prospects in the Kootenay region, and definition of the Laredo white calcium carbonate resource on Aristazabal Island on the North Coast. Some of the best jade in the world is recovered at Cassiar and mined at the Polar Jade and other deposits in northern B.C. New finds of precious opal near Burns Lake and Falkland attracted the interest of prospectors and gemologists.

Paul Wojdak
Regional Geologist, Smithers

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PART A

REVIEW OF EXPLORATION AND MINING ACTIVITY

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NORTHWEST REGION

by Paul Wojdak, P. Geo.
Regional Geologist, Smithers

SUMMARY

The exploration highlight of 1999 was the outstanding drill intersection at Silvertip which prompted Imperial Metals Corp. and Peruvian Gold Ltd. to re-open the underground workings for a major diamond drilling program in early 2000. Freeport Copper Company, a major international producer, optioned the Zymo porphyry copper prospect from local prospectors and conducted a substantial initial drilling program. The acquisition is encouraging for other prospectors. Exploration activity, down again in 1999, was focused in the Babine and Smithers districts. As in 1998, there was comparatively little work on advanced projects. Luscar Coal Ltd. has yet to submit its Project Report for the Telkwa thermal coal project and progress through the environmental assessment process is stalled.

Eskay Creek mine increased gold and silver production, and continues to be the leading economic performer among producers in the entire province. Drilling in the vicinity of the mine by Homestake Canada Inc. was the largest exploration project in the region, but no new discoveries were made. Golden Bear enjoyed its second profitable season of heap-leach mining, recovering more gold than expected for Wheaton River Minerals Ltd. Late in the year, Wheaton River acquired the dormant Red Mountain gold prospect near Stewart, and propose to place it into production in two years. Endako molybdenum mine drew most of its ore from low-grade stockpiles in order to reduce operating costs. Huckleberry copper mine completed the East zone starter pit and switched to development of the Main zone. Snip gold mine closed due to depletion of reserves, but was very successful over its eight-year life.

Among industrial mineral projects, Cassiar Mines and Metals Inc. reconstructed the existing dry mill to recover chrysotile asbestos from surface stockpiles remaining from the previous open pit and failed underground mine. Orinda Investments Limited and North Pacific Stone Limited began work to develop the Laredo limestone deposit on Aristazabal Island. Discoveries of precious opal in Tertiary volcanic rocks in the Lakes District sparked considerable interest by prospectors.

EXPLORATION TRENDS

Exploration spending in the Northwest declined to a new low; $5.585 million from $8.7 million in 1998 and $28 million the preceding year (Figure 1). Exploration drilling, an indicator of work on advanced properties, fell to 27 353 metres from 43 000 metres and 102 000 metres in the two prior years (Figure 2). The number of new mineral claim units declined to 2090 and there were 7577 forfeited mineral claim units, resulting in a net decrease of 5487 units in good standing (Figure 3). These claim data show the slump in grassroots exploration continues.

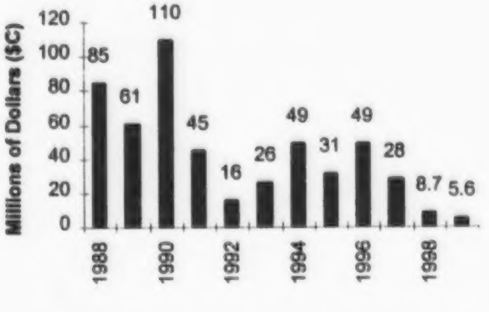

Figure 1. Mineral exploration expenditures in Northwest British Columbia.

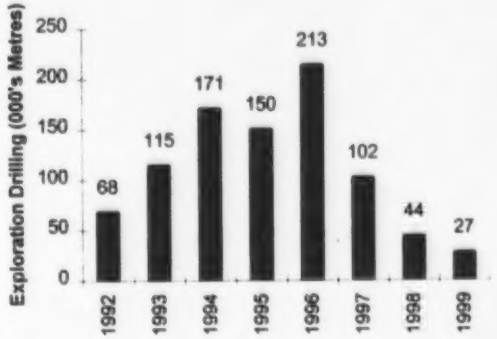

Figure 2. Exploration drilling in Northwest British Columbia.

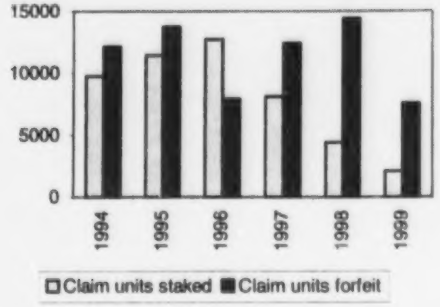

Figure 3. Claim summary, Northwest British Columbia.

Mine production in 1999, and reserves on January 1, 2000 are listed in Table 1. The location of mines, advanced exploration and early stage projects are shown on Figure 4. Table 2 lists properties with expenditures in excess of $100 000. Gold and silver are the commodities most sought after. The preferred exploration target is massive sulphide deposits, of volcanogenic or manto types. Among the exploration projects, Len/Ful, Quill, RDN and Zymo are comparatively new.

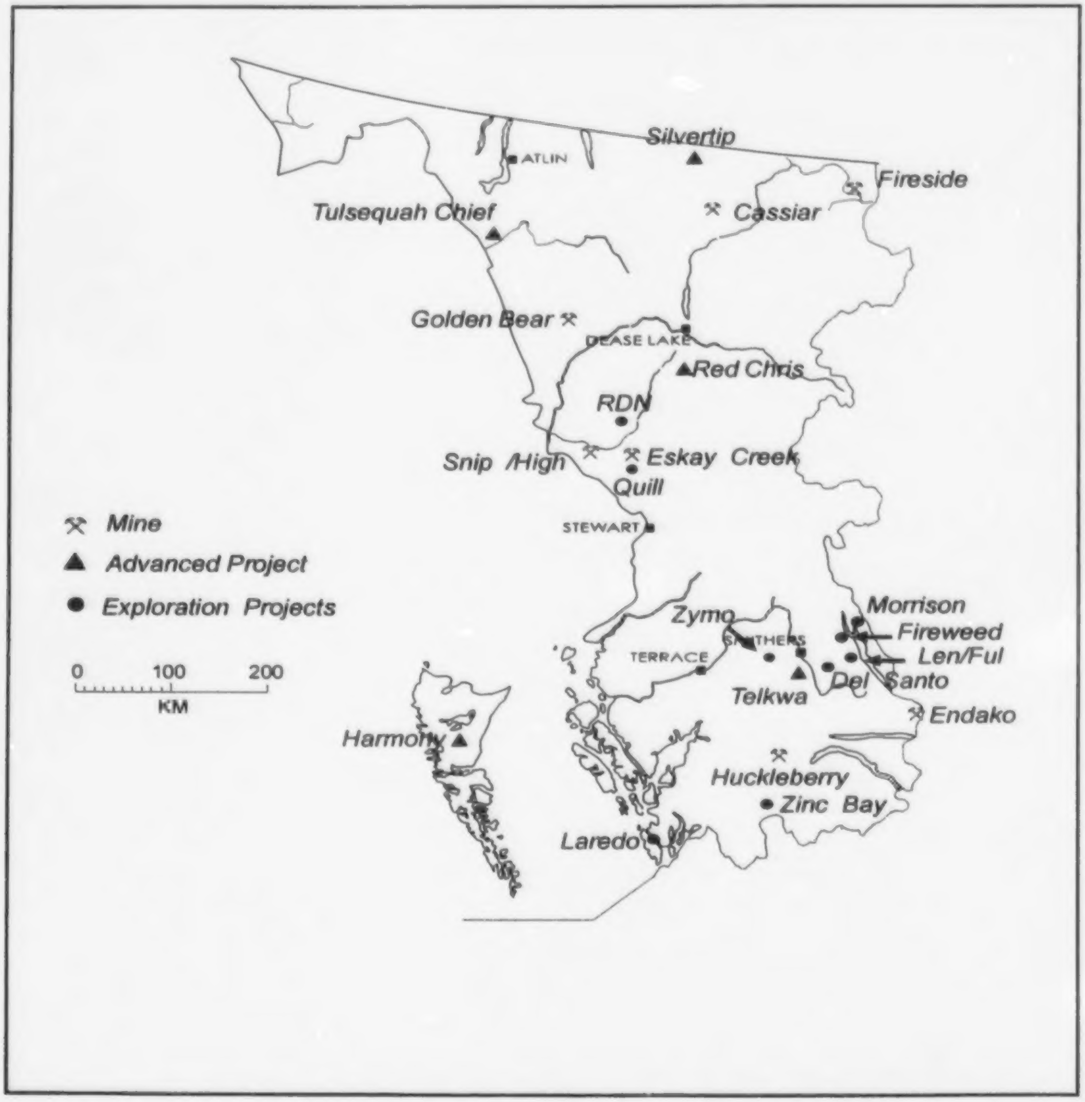
Silvertip
ATLIN
Fireside
Tulsequah Chief
Cassiar
Golden Bear
DEASE LAKE
Red Chris
RDN
Snip /High
Eskay Creek
Quill
STEWART
Mine
Advanced Project
Exploration Projects
0 100 200
KM
Zymo
SMITHERS
TERRACE
Morrison
Fireweed
Len/Ful
Del Santo
Telkwa
Endako
Harmony
Huckleberry
Zinc Bay
Laredo

Figure 4. Location map, mines and exploration projects in northwest British Columbia, 1999.

METAL MINES

The **Eskay Creek** mine is a major producer of gold and silver despite mining only 470 tonnes of ore per day. Mine crews travel to and from the mine by a 310-kilometre flight from Smithers, and an additional 60 kilometres by road, and work on a rotational basis. Daily mine production consists of 270 tonnes of direct shipping ore from the 21B zone and about 200 tonnes of mill ore from the NEX and 109 zones. In the 21B zone, stratiform clastic beds of massive sulphosalts and sulphides (Figure 5) are interbeded with mudstone and folded into the tight, north plunging, Eskay Creek anticline. The NEX zone lies in the hinge of the fold. The 109 zone is a pipe-shaped siliceous zone in the footwall rhyolite, stratigraphically below the bedded ore zones. The 21C zone, also in the footwall rhyolite, was developed from a 475 metre decline ramp in 1999. Geological mapping, definition drilling and extraction of a 600-tonne bulk sample were done to assess detailed ore controls, mining conditions and milling characteristics. The 21C resource was converted into a mineable reserve, with a higher silver grade than determined by surface drilling, but unfortunately poor ground conditions were encountered such that drift-and-fill mining will be required, as in the 21B zone. Development of the 21C zone will lead to increased production of mill ore in 2000 and warrant expansion of the mill to 250 tonnes per day. Currently, waste rock and mill tailings are trucked 10 kilometres to Albino Lake for underwater disposal. The company proposes to replace this system with a 6.4-kilometre tailings pipeline to Tom MacKay Lake.

Exploration drilling, which has discovered 3 million gold equivalent ounces since the mine opened in 1995, did not find a new resource zone in 1999. Deep holes tested the west and east limbs of the Eskay anticline, and along the north plunge trend of the NEX zone.

Figure 5. Eskay Creek 21B zone, minor folds in sulphide and mudstone beds.

Endako obtained about 60% of mill feed from its low-grade stockpile, in order to lower operating costs. Stockpile ore is wet (frozen in winter) and sticky, resulting in handling problems, so that the percentage of stockpile ore processed was higher in summer and lower in the winter months. The stockpile grades about 0.056% Mo and is blended with higher grade pit ore. During 1999, pit ore was mined from an area very close to the primary crusher, on the upper benches of the Endako pit, and graded 0.078% Mo. In early 2000, pit ore will be supplied from the long-inactive Denak West pit, despite its higher lead and bismuth content which halted previous mining. Work continued on assembly of an in-pit crusher and construction of a conveyor ramp on the north wall of the Endako pit. It is expected to be in operation by mid-2000 and will reduce mining costs by about 50%. The mill processed 8 706 164 tonnes, operating at 28 000 tonnes per day except for a one-month shutdown in July. Reserves are sufficient for about 11 years of continued production. The mine is located 20 kilometres from the community of Fraser Lake.

The Endako deposit is a quartz-molybdenite vein stockwork within the Late Jurassic to Early Cretaceous Francois Lake batholith, a multiphase intrusion of granite, quartz monzonite and alaskite. Mineralization is controlled by east, northeast and northwest-trending fractures and is separated into three main zones (Endako, Denak East and Denak West) by northeast-striking, normal oblique faults.

Huckleberry open-pit porphyry copper mine, located 122 kilometres by road southwest of Houston, completed its second year of operation. Mill throughput was 6 952 300 tonnes, about 20 500 tonnes per operating day, and averaged 0.586% Cu and 0.017% Mo. A 10% increase in capacity is under consideration. The East zone starter pit was completed in December and mining switched to the Main zone. Due to a lower copper price than anticipated in the feasibility study, Main zone reserves were reduced, and mining of the East zone will resume in 2001.

The Main zone is in Hazelton Group andesite hornfels on the east margin of a biotite granodiorite stock. The stock contains about 0.2% Cu, below the cutoff grade, and tenor of mineralization is better in the hornfels zone. Intrusions and mineralization at Huckleberry are controlled by a fault that strikes at 110°. The Main and East zones lie within an alteration zone and an induced polarization anomaly, surveyed 30 years ago, that is open to the west in an area covered by glacial till. The survey was extended in 1999 to explore this prospective area.

TABLE 1. 1999 MINE PRODUCTION AND RESERVES

Mine	Operator	Employment	Production	Reserves (Jan 1, 2000)
Endako	Thompson Creek Mining, Ltd. & Nissho Iwai Moly Resources Inc.	219	4 099 748 kg Mo	Pit ore, 80.1 million tonnes at 0.0737% Mo Stockpile, 30.2 million tonnes at 0.048% Mo (on Oct. 1, 1999)
Eskay Creek	Homestake Canada Inc.	234	9934 kg (308 985 oz) Au, 422 627 kg Ag	Shipping ore, 747 000 tonnes at 71 g/t Au, 3282 g/t Ag Mill ore, 713 500 tonnes at 30.7 g/t Au, 1357 g/t Ag
Golden Bear	Wheaton River Minerals Ltd.	90	2227 kg (71 600 oz) Au	Ursa, 224 000 tonnes at 8.65 g/t Au Kodiak B, 184 000 tonnes at 8.67 g/t Au
Huckleberry	Huckleberry Mines Ltd.	220	37 032 523 kg Cu, 443 000 kg Mo, 381.9 kg Au, 8 860 kg Ag	Main, 15 593 000 tonnes at 0.519% Cu, 0.014% Mo, 0.071 g/t Au 2.265 g/t Ag East, 46 169 000 tonnes at 0.488% Cu, 0.014% Mo, 0.056 g/t Au, 2.925 g/t Ag
Snip	Homestake Canada Inc.	0	1350 kg (43 390 oz) Au	Reserves exhausted, closed, June 1999
Table Mountain	Cusac Gold Mines Ltd.	0	21.7 kg (698 oz) Au	Shut down

Golden Bear mine is a Carlin-type gold deposit, located 250 kilometres by road northwest of Dease Lake. An open pit was developed on the Ursa oxide gold deposit and the ore crushed and stacked on the adjoining Totem Creek heap-leach pad (Figure 6). Ore tonnage and grade were better than anticipated and contributed to a low production cost of US$159 per ounce, despite a 7:1 stripping ratio. After mining was completed for the season, the remainder of Kodiak A ore was added to the Totem pad. Mining of the Ursa pit will be completed in 2000 and attention will move to underground mining of Kodiak B, another small oxide zone gold deposit.

The Ursa gold zone is in thin-bedded graphitic limestone where it is strongly brecciated along the Ursa fault, a splay of the regional Ophir break. The Ursa fault sets graphitic limestone, which is decalcified and silicified, against non-mineralized cherty dolomite. Gold in the oxide deposits is associated with hematite. Recovery by cyanide heap-leaching is rapid to better than 90%, implying that the gold is loosely held on fracture surfaces and not encapsulated in silica (A. Hamilton, pers. comm.).

Mine site exploration was not fruitful. Two deep core holes were drilled beneath Kodiak A to test the same elevation as the Ursa and Kodiak B deposits. Three short holes explored the north extension of the Ursa fault. A gold geochemical anomaly in decalcified rocks in the South zone, 1000 metres south of the Kodiak pit, was evaluated with three more drill holes. Other geochemical and structural targets were tested by percussion holes, considered to be more effective than trenching in permafrost.

The **Snip** underground gold mine closed on June 4 and site reclamation was nearly complete by year-end. The Bronson Creek airstrip will remain as important infrastructure for future exploration. Snip may be the only modern mine in the world to operate successfully without any ground or ocean access. From its opening in January, 1991 Snip produced 32 817 kg (1 055 000 ounces) of gold from 1 303 500 tonnes of ore milled. Prior to closure, International Skyline Gold Corp., under agreement with Homestake Canada Inc., extended the Snip 412 drift across the common property boundary onto the **High** claims, to conduct diamond drilling to explore for the strike extension of the Snip deposit. The 412 No. 1 and No. 2 veins were tested on five sections 25 metres apart. A change in rock type, from graywacke biotite hornfels at Snip, to siltstone and feldspar porphyry dikes on the High claims, appears not to be conducive to britttle-ductile shearing that characterizes the Snip deposit (D. Yeagher, pers. comm.). Biotite wallrock alteration was found to be weaker on the High claims. The 412 veins were found to be continuous, despite the change in lithology and intervening feldspar porphyry and lamprophyre dike zones. The highest grade intercepts were 8.6 g/t Au over 1.5 m and 9.0 g/t Au over 0.5 m, and were considered insufficient to justify more work.

At **Table Mountain** mine, 100 kilometres by road north of Dease Lake, Cusac Gold Mines Ltd. milled a small stockpile of ore that it mined from the Bear vein in 1998. The site has been inactive since April; the company was unable to finance exploration of gold-bearing quartz veins east of the Erickson fault. West of the fault, these veins have produced 7000 kilograms (225 000 oz) of gold.

TABLE 2. MAJOR EXPLORATION AND DRILLING PROJECTS IN NORTHWEST REGION, B.C.

Property (Owner)	Minfile	NTS	Commodity	Deposit Type	Work Done
Eskay Creek (Homestake Canada Inc.)	104B 008	104B/9	Au, Ag, Zn, Cu	Epithermal VMS	Drill access trail, 1 km; 64 ddh, 14 174 m
Fireweed (Mansfield Minerals Inc.)	93M 151	93M/1	Ag, Zn, Pb	Stratabound	Drill access, 1.5 km; 6 ddh, 1250 m
Golden Bear (Wheaton River Minerals Ltd.)	104K 079	104K/1	Au	Carlin	Drill access, 0.25 km; 8 ddh, 1200 m; 100 pdh, 3000 m
High (International Skyline Gold Corp.)	104B 077	104B/11	Au	Mesothermal shear vein	U/g drift, 198 m; 17 u/g ddh, 1495 m
Laredo (North Pacific Stone Ltd.)	103A 001	103A/11	Limestone	Industrial mineral	Geol; 28 ddh, 760 m
Len/Ful (Hudson Bay Exploration & Development Co. Ltd.)	93L 213, 242	93L/9, 16	Cu, Zn, Ag, Au	VMS	Drill access, 0.48 km; 7 ddh, 1095 m
Quill (Petra Resource Corp.)	104B 231	104B/7	Au, Cu	Mesothermal shear vein	Geol; 7ddh, 410 m
RDN (Rimfire Minerals Corp.)	104G 144	104B/15, 104G/2	Au, Ag	Epithermal VMS	Geol; linecutting, 1.9 km; 9 ddh, 574 m
Silvertip (Imperial Metals Corp.)	104O 038	104O/16	Ag, Zn, Pb	Manto	CSAMT, 5.65 km; 3 ddh, 1285 m; u/g rehab
Zymo (Freeport Copper Company)	93L 324, new	93L/13	Cu, Au	Porphyry	6 ddh, 1482 m

ATLIN PLACER DISTRICT

by Daryl Hanson, P. Eng. (Geol), Inspector of Mines

Placer gold exploration and mining activity in the Atlin Mining Division remained at about 1998 levels. Approximately 310 kilograms (10 000 troy oz) of gold was produced from 14 mining operations with a total of 57 seasonal workers. Most operators continued their search for previously unworked sections of pay channels close to historic workings, although three operators developed new pits in areas without prior production. Two of the new pits required more than 30 metres of stripping. The trend toward more low-cost "New Zealand" floater plants (Figure 7) continued in 1999.

As in the previous year most of the mining and exploration work was concentrated on the historic creeks in the camp. On **Wright Creek**, Sisters Resources Ltd. developed a pit, 30 metres deep, in order to continue mining an older channel that was discovered in 1998. In addition, they explored downstream with 425 metres of drilling and discovered a new zone that may be developed in 2000. West Coast Paving Co. Ltd. mined shallow ground further upstream on the main channel. On **Ruby Creek**, Ruby Gold Ltd. continued stripping Quaternary basalt in order to follow the pay channel on the east side of the present valley. Further upstream, West Coast Paving Co. Ltd. drilled 335 metres and located the pay channel on the west side of the valley, under 30 to 40 metres of basalt. Fat Chance Placer Inc. temporarily abandoned its deep pit at the top of the alluvial fan on **Boulder Creek**. Instead, it explored by trenching along the base of the western highwall and discovered previously unworked high-grade, orange-coloured (Tertiary?) gravel on top of bedrock. Further upstream, Southpaw Ventures Ltd. stripped a pit on the east side of the valley, but failed to locate a continuation of the pay channel. On **Wilson Creek** Gary Crawford and Peter Burjoski began stripping 30 metres of overburden over a deep channel that was located by percussion drilling. **Spruce Creek** continued to be active in 1999 although the focus shifted from processing large volumes of low-grade material to selective mining of high-grade channel gravel. Daniel Johnson, Kim Ferguson and Newstar Placer Inc. used floater plants to work shallow ground in the steep, middle section of the creek, while R&L Godkin Contractors Ltd. developed a small pit with conventional equipment in the flat lower section. On **Pine Creek**, John Zacharias excavated a large pit to bedrock along the northern rim just east of the abandoned Discovery townsite and Kim Ferguson completed three floater pits along the southern rim. The base of the northern highwall of **McKee Creek** was excavated by Bruce Wrightson resulting in the discovery of high-grade channel gravel on top of bedrock. Arrow Minerals Ltd. used a floater operation to mine an area of old tailings and to test some new ground on **Consolation Creek**.

Figure 6. Totem heap leach-pad being loaded with Ursa ore (dark coloured) and Kodiak A ore (light coloured). The pond in the foreground is for drainage control from storm events.

The planned new development of a significant floater operation on **Turn Creek** by Turn Creek Resources Ltd. was postponed due to problems with the winter access trail. It has been rescheduled for 2000.

INDUSTRIAL MINERAL AND GEMSTONE OPERATIONS

At the former **Cassiar** mine, Cassiar Mines & Metals Inc. (previously Minroc Mines Inc.) rebuilt a dry mill, at a cost of $5 million, using the old structure and recycling old equipment. Start-up is expected in January, 2000. Capacity of the facility will be 720 tonnes per day, one-fifth of the old plant. Mill feed will be supplies of pit ore left on site when the mine attempted to convert to underground mining in 1991. These total about 4 000 000 tonnes with an anticipated recovery grade of 5% chrysotile fibre. The historic grade was 10% recovered. Most of the current resource is talus which 50 years ago covered the original chrysotile deposit to a depth of 60 metres. The chrysotile talus was pushed aside in favour of bedrock ore when the pit was developed, and pit wasterock dumped beside it. The wasterock eventually formed a rock glacier and transported the talus ore 1.5 kilometres down slope, but remarkably, it remained a coherent body. Other stockpiles are beside two tram lines and the +2 inch coarse rejects. About 138 000 tonnes of material, mainly talus ore was recovered, screened and trucked to the mill site. The wet-milling pilot plant was not operated in 1999 because in 1998 it was found to be too slow to be viable. The long-range plan is to operate the wet mill as a continuous circuit with the dry mill and, ultimately, to process 17 000 000 tonnes of tailings.

Fireside Minerals Inc. mined 36 000 tonnes from the West Bear pit on the **Fireside** deposit (94M 003) 125 kilometres east of Watson Lake. Crushing and sorting by jigs resulted in recovery of 23 000 tonnes of barite, almost twice last year's production. The barite was trucked to Watson Lake for grinding and bagging, and marketed in the northeast British Columbia and Alberta oil drilling industry. There are sufficient reserves for two or three more years of quarry mining.

Figure 7. "New Zealand" style floating wash plant, fed by an excavator, at Kim Ferguson's placer mine on Pine Creek.

Nephrite **jade** was mined from three localities in the Turnagain River area east of Dease Lake. The Jade West Group mined 55 tonnes from the Kutcho deposit and 35 tonnes from the Polar jade deposit. Frank Plut sold the Blue J property to Tony Ritter who produced about 50 tonnes of jade that was marketed through Jedway Enterprises Ltd. Jedway also sold 40 tonnes of high-quality jade recovered from the Cassiar waste dump.

EXPLORATION PROJECTS (BY CAMP)

BABINE CAMP

South of Fulton Lake, Hudson Bay Exploration & Development Company Ltd. drilled seven wide-spaced holes (2 to 12 kilometres apart) on the **Len** and **Ful** claims in search of a volcanogenic massive sulphide deposit. The area is covered by 20 to 40 metres of glacial till. Drilling was the culmination of a systematic grassroots program that began with an airborne electromagnetic survey, followed by ground EM, soil geochemistry and geological surveys. The holes encountered various stratigraphic units including graphitic argillite and augite-porphyritic basalt (probably Takla Group), sulphidic argillite (probably Nilkitkwa Formation), heterolithic red and green andesite (Telkwa Formation) and poorly lithified volcanic breccia with a coal seam (Eocene Newman Formation).

The **Fireweed** (93M 151) silver-zinc-lead prospect, 50 kilometres northeast of Smithers, was reactivated by Mansfield Minerals Inc. in a joint venture with Cedar Capital Corp. Two contrasting styles of mineralization occur within Cretaceous sedimentary rocks; small tabular zones of massive, fine-grained pyrrhotite, pyrite, sphalerite and galena (mantos?) and disseminated pyrite, marcasite, sphalerite, galena and tetrahedrite. The latter is stratabound within grey sandstone beds of a monotonous sequence of interbedded black siltstone and sandstone. Previous work outlined a resource of 580 000 tonnes grading 342 g/t Ag, 2.2% Zn and 1.3% Pb. The current program was designed to test mineralization in the 1600 zone along strike and down-dip. When visited on October 21, two very narrow, sheared and altered, quartz latite dikes had been intersected. These are similar to wide spaced dikes intersected previously on the property,and may be derived from a buried Eocene Babine stock, suggesting an intrusive link to mineralization.

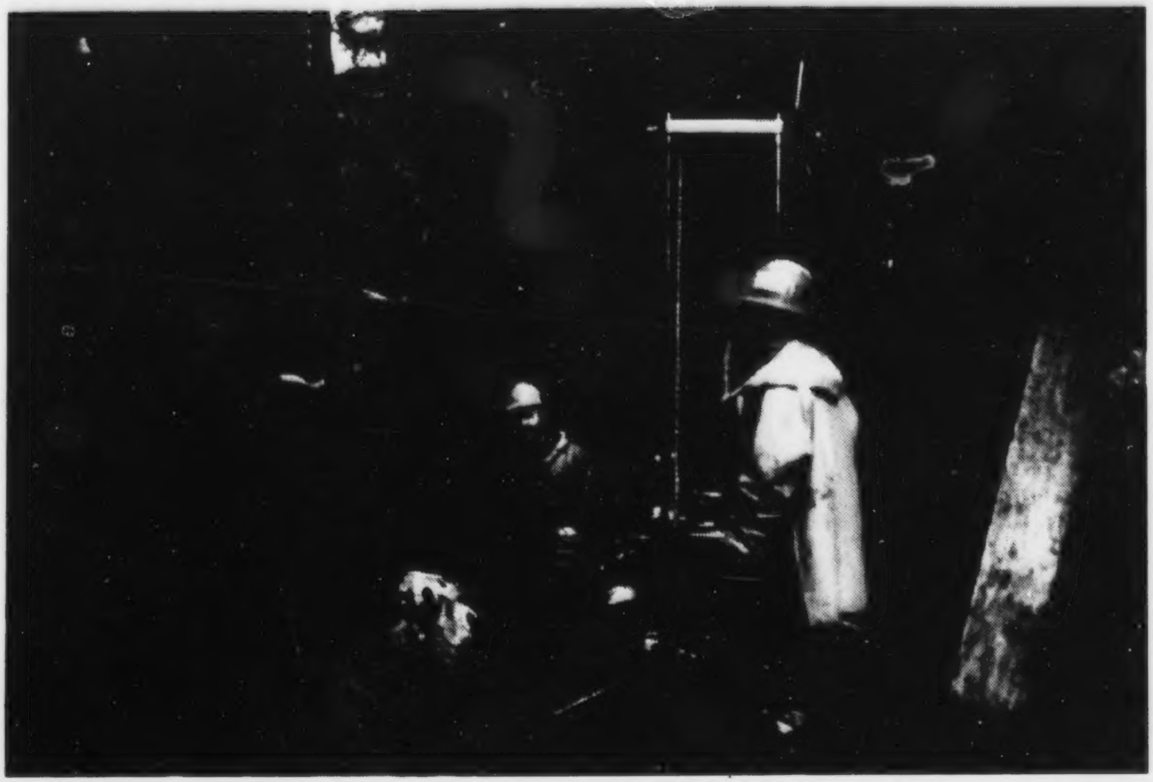

Figure 8. Project geologist, Ron MacIntyre (far left), and Mines Branch inspector, Bruce Graff (second from left), inspect Winkie drilling at the Laredo limestone project.

Booker Gold Explorations Ltd. drilled a single 307-metre hole in the middle of the **Morrison** (93M 007) porphyry copper deposit. Previously, Noranda Inc. estimated the deposit contains 190 million tonnes grading 0.40% Cu and 0.20 g/t Au, based on drilling to about 180 metres below surface. Copper grade is fairly uniform in Booker Gold's drill hole and averaged 0.75% Cu and 0.40 g/t Au over its full length.

TAHTSA CAMP, HOUSTON AREA

At **Zinc Bay** (93E 030), on Whitesail Lake, Michael Renning and Scott Gifford relocated old showings and completed 12 kilometres of VLF, magnetic and geochemical surveys. The target is polymetallic veins, or possibly a volcanogenic massive sulphide deposit. The property was not visited.

Bob Hamblin carried out percussion drilling with an air-track drill on two porphyry copper properties south of Houston; the **Shea** near Gabriel Creek and the **Dual**, south of Gordeau Lake.

The search for **precious opal** in Tertiary volcanic rocks in the Burns Lake area drew the interest of local prospectors and opal dealers from as far away as Australia. Dennis Schaefer's Firestorm prospect sparked the interest, and his family continued a hand-mining operation recovering an estimated several thousand carats of material. A marketing agreement was made with GeoGem Lapidary Services and a package of stones was sent to Sri Lanka for cutting into fininshed gemstones. A 92-carat stone, uncut, was offered for sale at $15 000. Other prospectors have found common opal, but not precious opal.

Bruce Holden, Randy Lord and Larry Hamula continued to work on the **Northern Lights** precious opal prospect in the Whitesail Range, 10 kilometres south of Huckleberry mine. A miniature excavator was flown to the property by helicopter to work the basaltic lahar and amygdaloidal flows which contain the precious opal. About 400 kilograms was hand-sorted and removed for gem cutting.

SMITHERS CAMP

Freeport Copper Company, a subsidiary of Freeport-McMoRan Copper & Gold Inc., acquired the **Zymo** (93L 324) porphyry prospect on Mulwain Creek, near the head of the Zymoetz (Copper) River. Six drill holes were sited on swampy "kill zones", believed to be derived from underlying sulphide-rich bedrock, within a copper soil geochemical anomaly. A weak quartz-pyrite-anhydrite stockwork was intersected in a phyllic altered granodiorite. Only trace amounts of chalcopyrite were seen in the core (B. LaPeare, pers. comm., 1999).

Telkwa Gold Corporation continued to explore the **Del Santo** (93L 025) volcanogenic massive sulphide prospect 35 kilometres southeast of Smithers. The company carried out a seismic survey to determine overburden depth, prior to excavator trenching of a strong magnetic and electromagnetic anomaly 500 metres north of the main showing. Subsequently, one hole was drilled but only mafic volcanic rocks were encountered and the anomaly remains unexplained. For further information see *Exploration and Mining in B.C. - 1998*, page 27 and page C1-C13.

TERRACE AREA

Prospector Paul Wadsworth discovered a narrow quartz-scheelite vein containing spectacular free gold. **The Hope** claims are reached by traveling 6 kilometres on the Cedar Creek forest service road, 20 kilometres north of Kalum Lake. The Wadsworth vein is in Bowser Lake Group graywacke and pebble conglomerate close to a granitic intrusion. About 2000 kilograms of material were recovered by hand mining, estimated by the owner to contain several hundred grams of gold per tonne (W. Bulmer, W. Hansen, pers. comm. 1999). The claim owners, Wanita Hansen and Paul Wadsworth, are seeking an agreement to develop the prospect.

NORTH COAST AREA

The **Laredo** marble deposit (103A 001) on Aristazabal Island is being assessed by Orinda Investments Limited under option from North Pacific Stone Limited, for high-purity and high-brightness calcium carbonate filler for a variety of industrial products (paper, paint, plastics). Small shipments were made during the 1950s and 1960s to a local pulp mill and some important site infrastructure remains, such as roads, cleared areas and a quarry face. The marble is metamorphosed and coarsely recrystallized Permian(?) limestone. Trace amounts of phlogopite, olivine and pyrrhotite have been seen in thin sections (R. MacIntyre, pers. comm.). Greenstone lenses and dikes of andesite and granitic composition occur locally.

A detailed surface sampling and geological mapping program were conducted. When visited on Nov. 11, drilling was in progress on a 50-metre grid. The drilling was done with considerable difficulty using a hand-portable Winkie drill (Figure 7) recovering B-size core. This information will be used to calculate resource purity and tonnage. Orinda also carried out engineering design, environmental studies, market research, product testing, liasion with the Kitasoo First Nation and discussed permitting requirements with the Ministry for a seasonal, 450 000-tonne per year operation.

QUEEN CHARLOTTE ISLANDS

The Ministry conducted regional silt geochemical and geological surveys, under the Crown Resource Inventory Initiative (CRII program), in preparation for a public land planning table. Geological surveys comprised an update to MINFILE, to be released shortly, and examination of mineral occurrences to validate published descriptions and deposit models. The geochemical survey targeted the area underlain by Masset Formation on southern and central Graham Island, and northern Moresby Island.

STEWART CAMP

In a major development late in the year, Wheaton River Minerals Ltd. reached agreement with Pricewaterhouse Coopers Inc., the interim receiver of Royal Oak Mines Inc., to purchase the **Red Mountain** (103P 086) gold property. The company plans to develop the deposit by 2002, as a seasonal mine producing 150 000 tonnes of ore per year. The 127 000 metres of drill core, carefully stored in Stewart, is regarded as an important asset for planning future exploration.

On the **Mountain Boy** (104A 011) property on American Creek, Ranmar Ventures Ltd. made improvements to a steep access trail to the Mann adit and benched a working area at the portal. A 180-tonne shipment of baritic silver-lead-zinc ore was not made in 1998, as erroneously reported last year, but remains stockpiled on the property. Late in the year, 15 tonnes of ore from the High Grade vein (refer to *Exploration and Mining - 1998*) were shipped to Trail. The smelter reported an average head grade of 2.5% Pb, 1.1% Zn and 18 850 g/t Ag.

Geofine Exploration Consultants Ltd. mapped and prospected the **Todd Creek** (104A 001) claims, 45 kilometres northeast of Stewart, to select drill targets for joint venture partners Island-Arc Resource Corp. and Okak Bay Resources Ltd. The target is an epithermal gold deposit.

ISKUT CAMP

On the **RDN** (104G 144) claims, 25 kilometres west of Bob Quinn, Rimfire Minerals Corporation drilled four holes exploring for an Eskay Creek type deposit. A two-hole fence in the Marcasite Gossan penetrated the favourable stratigraphy from pillow basalt in the hangingwall, through argillite with laminated pyrite, and two stacked dacite flow domes with footwall stockwork veining. No significant gold values were encountered but anomalies in mercury, arsenic and antimony support interpretation of an Eskay Creek environment. Two holes failed to reach target depth in sheared graphitic argillite beneath a strong gold-arsenic-lead-silver soil anomaly adjacent to a sericite-pyrite-altered rhyolite. Three more RDN holes tested quartz-sulphide veins in the Wedge and Main zones, but intersected lower gold grade than surface sampling. A more detailed geologic description of the RDN property is given in *Exploration and Mining in British Columbia - 1998.*

The **Quill** (104B 231) property, 22 kilometres south of the Eskay Creek mine, was drilled by Petra Resource Corp. in search of a gold-rich quartz vein, similar to Snip. The holes targeted a VLF-EM conductor that corresponds to a shear-hosted vein. Drilling followed the vein about 100 metres but vein intercepts were more narrow and lower grade than on surface. One hole could not be completed where the shear zone is wider than in the other holes.

Reclamation of the **Sulphurets** exploration site near Brucejack Lake was done by Newhawk Gold Mines Ltd. Potentially acid generating waste rock and gold ore, that had been extracted from the decline, was trucked to, and dumped into Brucejack Lake to prevent oxidation and acidic runoff.

STIKINE DISTRICT

Pathfinder Resources Ltd. optioned the **Erts** claims in the Telegraph Creek area, on the basis of impressive copper and gold assays. Examination determined the showing to be inconsequential, a silicified shear zone with prominent secondary copper stain. No work was done.

CASSIAR CAMP

Prospector Ray Adams conducted soil geochemistry on the **Shannon** claims near McDame Post, in the vicinity of the Carlick mineral showing (104P 023). The association of McDame limestone, felsite dikes, silicification and lead-zinc mineralization suggests good potential for a manto deposit like Silvertip. Because of the high spiritual values in the area, the Dease River Band of the Kaska Dene First Nation is strongly opposed to the development of this property.

Cusac Gold Mines Ltd. trenched along the 93-2 vein at **Taurus**, but found no continuity in grade or the vein-structure itself.

RANCHERIA CAMP

A three drill-hole program at **Silvertip** (104O 038) by Peruvian Gold Ltd. and Imperial Metals Corp. to test CSAMT anomalies resulted in the thickest intercept ever drilled on the property, and breathed new life into the project. Hole 99-2 returned 318 g/t Ag, 8.65% Zn and 5.53% Pb over 31.4 metres, and is interpreted as the first major intercept of a mineralized chimney structure. The core, examined on Sept. 13, exhibits multi-stage brecciation, magnetic pyrrhotite replaced by bladed pyrite and red-brown sphalerite. These are thought to indicate higher temperature mineralization and a more active depositional process. The intercept is in the Silver Creek south area (Figure 9), on the southern periphery of previous drilling, and is close to the Camp Creek fault which may be an ore-controlling structure. Mineralization found to date at Silvertip consists of irregular shaped mantos in McDame Group limestone below a regional Upper Devonian unconformity. Prior to the current program, the deposit was estimated to contain 2.57 million tonnes at a grade of 325 g/t Ag, 6.4% Pb, 8.8% Zn and 0.63 g/t Au.

The portal of the exploration decline was re-opened in October and 1500 metres of ramp and side drifts were pumped dry, to provide access to underground diamond drilling stations. The ramp begins in McDame limestone, where ground conditions are good, but passes into Earn Group shale above the unconformity, where ground conditions are poor. Considerable work was required to replace collapsed screening and rock bolts. Drilling is scheduled to begin in January, 2000.

TAKU - TULSEQUAH CAMP

At **Tulsequah Chief** (104K 002), Redfern Resources Ltd. quarried some limestone for remediation of acidic drainage from the old workings. The proposed mine continues to seek resolution of concerns held by the Taku River Tlingit First Nation and environmental groups. In a positive development, the State of Alaska declared its support for the mine in April.

Figure 9. Steve Robertson, project manager, overlooking drill hole 99-2 on the Silvertip project.

ACKNOWLEDGEMENTS

I am very appreciative of the gracious hospitality shown to me by geologists and prospectors. I thank all mine staff and explorationists for sharing their information with me. And thanks to all the Smithers office team for their help, especially Daryl Hanson who donated his time generously to assist with computer graphics.

NORTHEAST-CENTRAL REGION

By Bob Lane, P. Geo.

Regional Geologist, Prince George

SUMMARY

Mining and mineral exploration in northeast-central British Columbia experienced another difficult year. Four major mines, Kemess, Mount Polley, Quintette and Bullmoose (Figure 1) operated throughout the year, two fewer than in 1998. All managed to stay in production despite low commodity prices.

Exploration expenditures dwindled to the meager total of approximately $3.2 million, the lowest annual figure on record for the region. There were only ten major projects (Table 1), five fewer than in 1998 and eighteen fewer than in 1997. As in past years, exploration activity was focused on precious metal enriched porphyry copper prospects and auriferous vein deposits. For the second year in a row there was no activity in the Gataga lead-zinc-silver belt and for the first time in many years there were no drilling programs in the Nechako Plateau. Despite weaker statistics there is reason for optimism. The level of early stage exploration (including grassroots prospecting and geochemical sampling) did increase modestly in 1999 and there are several very encouraging discoveries to report.

HIGHLIGHTS

Significant developments to report in the Northeast-Central region include:

- Auriferous, polymetallic volcanogenic massive sulphides were discovered on the Frank Creek property, south of Cariboo Lake, by Barker Minerals Ltd.
- Eureka Resources Inc. optioned its promising Lottie VMS float prospect, north of Wells, to Hudson Bay Mining and Smelting.
- Alpha Gold Corp. reported encouraging assays from drilling of zinc-rich manto and copper skarn mineralization on its Lustdust property in the Omineca.
- The 50 000 tpd Kemess gold-copper mine, now owned by Northgate Exploration Ltd., completed its first full calendar year of production.
- Exploration drilling at the Mount Polley gold-copper mine identified two new areas of mineralization that may add tonnage to the mine's reserve base and expand pit development.
- Taseko Mines Ltd. bought the currently idle Gibraltar copper-molybdenum mine. It plans to aggressively explore the mine leases and has scheduled to reopen the mine in the fall of 2000.
- Several new showings were discovered by prospectors supported by British Columbia's Prospectors Assistance program.
- Pine Valley Coal Ltd. advanced the Willow Creek project, west of Chetwynd, towards production through continued assessment of its coal seams.
- A preliminary feasibility study of the Belcourt coal property was completed late in the year by Western Canadian Coal Corporation.
- The mothballed QR gold mine is being evaluated for development as a heap-leach operation by new owner Big Valley Resources Ltd.
- International Wayside Gold Mines Ltd. drilled the BC gold vein on the former Cariboo Gold Quartz mine at Wells.

METAL MINES

The **Kemess** open pit gold-copper mine, 300 kilometres northwest of Mackenzie, employs approximately 440 workers. The mine reached commercial production in October, 1998, however, it was not long before cash-strapped owner and operator, Royal Oak Mines Inc., encountered serious financial difficulties. In the spring of 1999, Royal Oak became insolvent and PricewaterhouseCoopers took over the reins of the operation as interim receiver. In the fall, the receiver arranged for the mine to be sold to Northgate Exploration Ltd. Court approval was granted in January, 2000. New ownership will provide much needed stability for the operation and capital for maintenance and improvements. Significant increases in metal recoveries in the mill have been realized since the spring. The mill processed a total of 14 152 085 tonnes of ore in 1999; throughput averaged

38 667 tonnes per day. Metal production for the first full calendar year of operation totaled 6625 kilograms (213 000 oz) of gold and 21 389 tonnes (47.154 million pounds) of copper and 7707.5 kilograms (247 806 oz) of silver. In general, mining has substantiated the deposit's geological and geostatistical models that were developed from exploration data. The mineable reserve for the Kemess South ore body, on January 1, 2000, was 163 million tonnes grading 0.668 g/t Au and 0.232% Cu, equivalent to 9.2 years of production.

Four ore types comprise the deposit, which developed within Early Jurassic quartz monzonite. Hypogene, transitional, supergene and leach cap ore types are mined and milled separately. Hypogene ore, consisting of disseminated and fracture-controlled pyrite and chalcopyrite, has a lower work index, and is more amenable to conventional flotation, than was anticipated. Supergene ore is characterized by pervasively hematite-altered hostrocks containing abundant native copper throughout and chalcocite near its base. Transitional ore displays characteristics of both hypogene and supergene ore types. Leach cap material is almost devoid of copper, but contains higher than average run-of-mine gold grades.

Blast-hole assays from hypogene ore immediately east of the 10-180 fault on the 1270 bench, outlined a prominent north-trending zone of higher grade gold mineralization. This zone has a core 40 to 50 metres wide by about 100 metres long that ranges in grade from 0.7 to more than 1 g/t Au and is associated with narrow, north-trending magnetite-pyrite-stibnite(?)-molybdenite veinlets. The enriched gold zone coincides with intense silica and K-feldspar alteration.

A 14-hole in-pit geotechnical drilling program evaluated the structural integrity of the North Block fault and may also provide valuable geological information for future property-scale exploration. Exploration is a high priority for the new owner.

The **Mount Polley** porphyry gold-copper mine (Photo 1) is owned and operated by Imperial Metals Corporation (52.5%) and SC Minerals Canada Ltd. (47.5%), a wholly owned subsidiary of Sumitomo Corporation of Japan. The open-pit operation, located 56 kilometres northeast of Williams Lake, employs approximately 240 workers. In 1999, the mill processed ore at a rate of about 19 400 tonnes/day. Tonnage milled for the year totaled 7.09 million tonnes, an increase of more than 21% over 1998. While gold head grades fell to an average of 0.566 g/t for the year (down 0.2 g/t from the 1998 average), metal recoveries for the year increased dramatically (to approximately 77% for gold and 69% for copper) from 1998 levels because of a lower than anticipated oxide:sulphide ratio of ore mined and increased mill efficiency. Production for 1999 totaled 3082 kilograms (99 092 oz) of gold (cf. 101 700 oz in 1998) and 16 400 tonnes (36.1 million pounds) of copper (cf. 23.9 million pounds in 1998). Ore was mined almost exclusively from the Cariboo pit, while development of the Bell pit was initiated. Since start-up, approximately 18.2 million tonnes of ore have been mined. A revised mineable reserve will be available in the spring.

A northerly trending belt of mineralized intrusion breccia, part of the Early Jurassic Polley stock, comprises the bulk of the ore at Mount Polley. Imperial Metals drilled 18 exploration holes along this trend to test three priority targets: 1) the northern and eastern margin of the planned Bell pit, 2) at depth within the south Cariboo pit, and 3) immediately south of the modeled Cariboo pit (east of the Polley fault) in the "C-2" zone or South Cariboo Extension. Results from Bell pit area holes were mixed. Cariboo pit holes intersected significant intervals of intensely hydrothermally altered and 'better-than-mine-grade' intrusion breccia that locally comprised semimassive magnetite and erratically disseminated chalcopyrite within an intense zone of K-feldspar alteration. There is excellent correlation between gold-copper grades and intensity of secondary K-feldspar(±albite)-magnetite-actinolite(±biotite) alteration. Encouraging results from the C-2 zone include a 54.3-metre intersection in hole 99C-2 that graded 0.309% Cu and 0.562 g/t Au.

Results from deep in-pit diamond drilling and exploration marginal to the Cariboo may result in modification of the ultimate pit design.

In the fall, Imperial Metals assessed the economics of the Spanish Mountain gold prospect near Likely. If proved feasible, ore would be mined from two small gold-quartz stockwork zones (Madre and LE) on the CPW claim, owned by Eastfield Resources Ltd., and trucked to the Mount Polley mill to be blended with ore from the Cariboo and Bell pits.

The **Gibraltar** open-pit copper-molybdenum mine, which was placed on care-and-maintenance in mid-December, 1998, was bought from Boliden Limited by Taseko Mines Ltd. It is expected to resume production in the fall of 2000. During the year, ongoing reclamation coincided with some stripping of overburden from the Connector zone. An aggressive minesite exploration program is planned for 2000 and will include a broad soil geochemistry program and diamond drilling.

The closed **QR** gold mine also changed hands in 1999. Big Valley Resources Ltd. purchased the mine from Kinross Gold Corporation, pending a final payment due April 30/2000. Big Valley is assessing the economics of developing a heap-leach operation in 2000 that would initially process existing low-grade stockpiles (220 000 tonnes grading 1.5 g/t Au) within the existing tailings impoundment. The property's current total mineral

Photo 1. Mining in the Cariboo pit, Mount Polley mine.

inventory is an estimated 750 000 tonnes averaging 3 g/t Au. Exploration is planned for 2000 in an area immediately east of the Main zone open pit.

COAL MINES

The region's two operating coal mines are located near Tumbler Ridge. Quintette and Bullmoose produce hard coking coal that is exported exclusively to Japan. During the year the Japanese benchmark price for hard coking coal decreased approximately 18% from the average price of US$50 in 1998 (B. Ryan, personal communication). The coking coal export market is adversely affected by a continuing oversupply of premium coking coals, primarily from Australia where mining conditions are easier and rail distances to ports shorter. In addition, China exports coke and increased its shipments in 1999 to an estimated 11 million tonnes. Therefore, prices for coking coal are expected to remain low for the next few years.

The **Quintette** coal mine, operated by Teck Corporation, produced an estimated 2.9 million tonnes of metallurgical coal in 1999. During the year, layoffs reduced the mine workforce to approximately 500. In 1999 approximately 2/3 of coal produced came from the Mesa/Mesa Extension developments and the remaining 1/3 from the Little Windy and Big Windy developments at Mount Babcock. Current clean coal reserves total approximately 12 million tonnes.

On March 1, 2000, Quintette Coal Ltd. announced that it would permanently close and reclaim Quintette. The mine will cease operations on August 31, 2000, two and one-half years ahead of schedule. Sales volume reductions and low coal prices (that averaged US$40.86/tonne for coal loaded at Prince Rupert), together with relatively high production costs, led to significant operating losses in 1999. Further coal price reductions take effect on April 1, 2000.

Annual production at **Bullmoose**, majority-owned by Teck Corporation, is expected to total 1.2 million tonnes in 1999, down from the 1.5 million tonnes agreed to in the recently renewed contracts with the Japanese steel industry. All production comes from the South Fork pit. Development of the West Fork deposit will not proceed under the prevaling economic conditions. The current mine workforce numbers about 245, but additional staff reductions are expected as the strip ratio is reduced during 2000. However, coal sales from Bullmoose are expected to increase in 2000 because of the announced closure of Quintette. The Bullmoose operation is expected to close in 2003 when mineable reserves at South Fork will be exhausted.

INDUSTRIAL MINERAL OPERATIONS

Canada Pumice Corporation produced approximately 30 000 cubic yards of screened and sized lava from its operation at the **Nazko** cone west of Quesnel. The major market for its products is still the Lower Mainland, but inquiries are growing and the operation may have to expand in the near future in order to meet demand. A small shipment was sent to Ontario for testing as a water filtration medium in this significant new market.

The **Ahbau** and **Giscome** railroad ballast quarries were active in 1999. The Ahbau quarry, 20 kilometres north of Quesnel, is owned by BC Rail and operated by Broda Construction Ltd. Broda processed 150 000 to 200 000 tonnes of andesitic basalt for use on BCR mainlines and spurlines. A limited amount of rip-rap was also stockpiled. At the Giscome quarry, 30 kilometres northeast of Prince George, Broda produced 250 000 to 300 000 tonnes of crushed and sized basalt for use on CNR rail lines. Each quarry operated for about two months and employed 12 to 14 workers.

The **Giscome limestone** quarry, 30 kilometres northeast of Prince George, near the hamlet of Giscome, was operated briefly by Pacific Lime Products Limited. The operation produced crushed, screened and sized limestone, totaling 8000 to 10 000 tonnes, to fill orders from two pulp mills in the region. In addition, numerous shallow percussion-drill holes and a six-hole diamond drilling program were focused primarily southwest of the active pit, an area of possible pit expansion. All holes bottomed in limestone. An expanded program will proceed in 2000 if assay results warrant.

Dimension stone operations were relatively quiet during the year. Small custom orders and/or limited quarrying took place at **Wishaw Lake** quartzite and **Aspen** monzonite. Small shipments of green slate from the **Dome Creek** site on Highway 16 were also made to the Lower Mainland. Several tonnes of soapstone were removed from an open cut on the **Trust** property northwest of Quesnel.

There was limited small-scale exploration and some staking activity for various industrial mineral commodities including barite, wollastonite, slate, dimension stone, limestone and marble.

PLACER GOLD MINING OPERATIONS

The level of activity in the placer mining sector decreased in 1999, following a downward trend that has continued over the past several mining seasons. No accurate estimate of dollars spent on testing is available, but expenditures are expected to be down from 1998. There were fewer major mining projects this year and, overall, the amount of processed material (paydirt) was down. No information is available on the quantity of gold recovered or grade of material washed.

As in past years, the Cariboo was the principal centre of activity. In the Wells-Barkerville camp, Tex Enemark mined roughly 5500 cubic metres of material from the face of the historic **Thistle** pit near Eight Mile Lake. Jack McKimmon worked an area on **Slater Creek**, above Jack of Clubs Lake, that showed evidence of historic surface and underground placer workings, including a flooded shaft and wooden flume lines and watergates. Monitor International Corp. continued its development of several leases on the **Quesnel River**. About 5000 cubic metres of material was processed by a team of four workers over a 26-week period. Near Likely, R. Harms conducted a program of trenching on tenure on the Quesnel River and processed 2500 cubic metres of paydirt. T. Miller, working on the nearby **Cariboo River**, mined 2000 cubic metres of paydirt from one main pit and five test trenches. L. Caron worked about eight weeks on the **Cottonwood River** and processed 2000 cubic metres of gravel, while J. Kleman was active on **Fraser River** gravel bars and managed to process about 1000 cubic metres. Other major watersheds that saw activity include **Antler Creek**, **Williams Creek**, **Swift River** and **Willow River**. There were a few programs scattered on each of **Cedar Creek**, **Keithley Creek** and **Snowshoe Creek**.

Photo 2. Excavating pay gravel from historic Thistle pit.

The two largest programs in the region, for which reliable information has been obtained, were located in the Germansen River - Manson Creek camp. Slate Placer Ltd. continued production from two main pits on several placer leases located on **Slate Creek**. In addition, some test pitting was conducted to outline future reserves. On nearby **Manson River**, a large program of testing and production was undertaken on a portion of SPML 1588 by 733857 Alberta Ltd. Approximately 30 000 cubic metres of paydirt was mined and washed from two large pits. A series of satellite trenches and test pits were dug

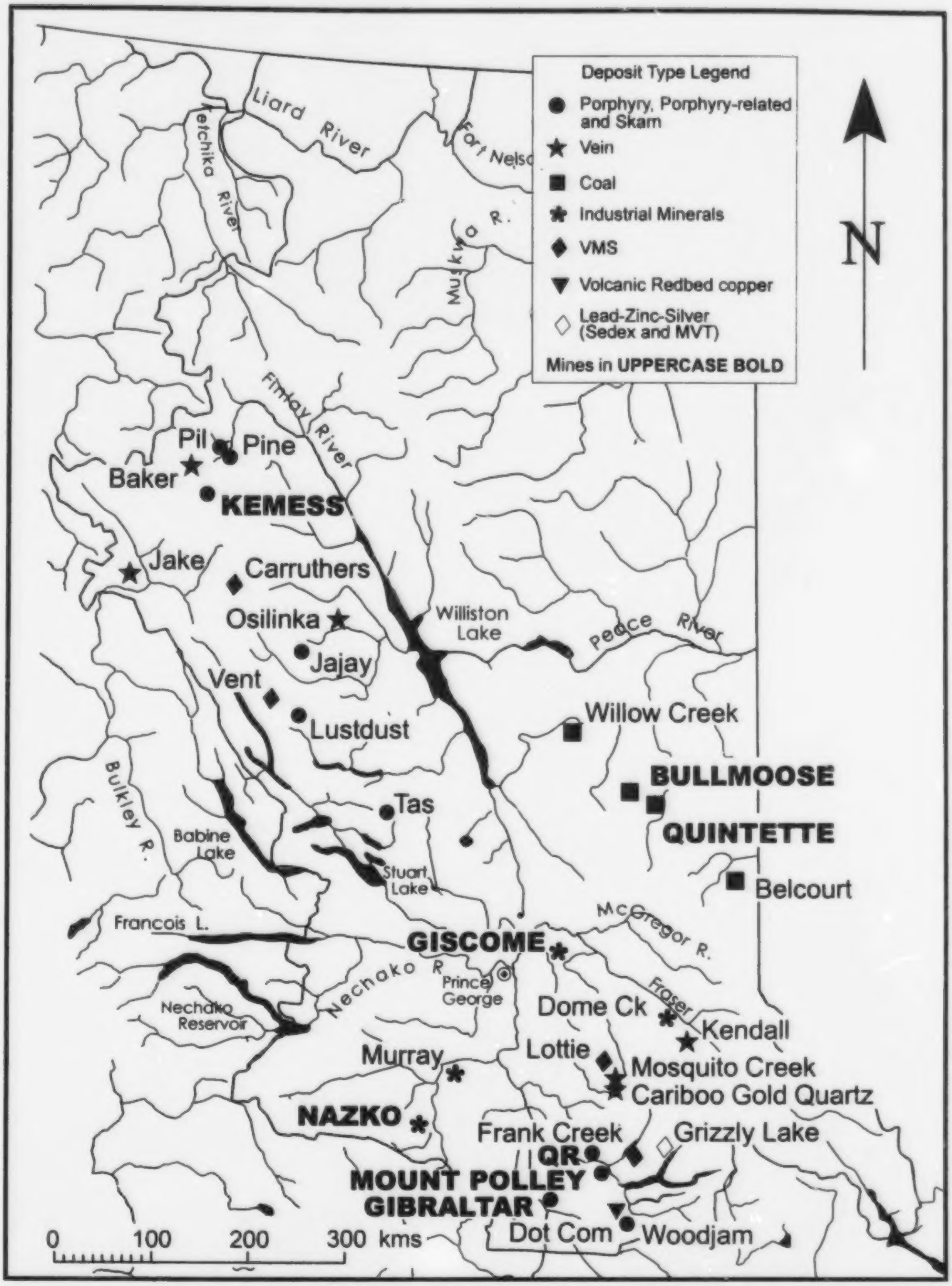
Deposit Type Legend
● Porphyry, Porphyry-related and Skarn
★ Vein
■ Coal
✱ Industrial Minerals
◆ VMS
▼ Volcanic Redbed copper
◇ Lead-Zinc-Silver (Sedex and MVT)
Mines in UPPERCASE BOLD
N
Liard River
Kechika River
Fort Nelson
Muskwa R.
Finlay River
Pil
Pine
Baker
KEMESS
Jake
Carruthers
Osilinka
Jajay
Williston Lake
Peace River
Vent
Lustdust
Willow Creek
BULLMOOSE
QUINTETTE
Tas
Bulkley R.
Babine Lake
Stuart Lake
Belcourt
McGregor R.
Francois L.
GISCOME
Nechako R.
Prince George
Nechako Reservoir
Fraser
Dome Ck
Kendall
Lottie
Mosquito Creek
Cariboo Gold Quartz
Murray
NAZKO
Frank Creek
Grizzly Lake
QR
MOUNT POLLEY
GIBRALTAR
Dot Com
Woodjam
0 100 200 300 kms

Figure 1. Operating mines, major exploration projects and selected early-stage prospects, northeast-central British Columbia - 1999.

to confirm continuity of prospective gravel horizons. Minor test work was conducted by Angel Jades Mines Ltd. on its **South Germansen River** tenure.

Seven programs were located in the Hixon area, mainly testing gravels on **Hixon** and **Terry** creeks. Gallery Resources Ltd. was honored by the British Columbia Technical and Research Committee on Reclamation for work conducted on its **Hannandor** property near Coldspring House in the Cariboo.

EXPLORATION TRENDS

The estimate for 1999 exploration expenditures in the region is $3.2 million (Figure 2), down approximately 34% from last year's total. The amount of exploration drilling also decreased sharply to 15 300 metres (Figure 3). There were ten major projects (those that involve mechanical disturbance and expenditures in excess of $100 000) in the region (Table 1), five fewer than in 1998. These include **Cariboo Gold Quartz, Mount Polley, Baker/Chappelle, Jake, Lustdust, Mosquito Creek, Pine, Tas, Willow Creek** and **Woodjam** (Figure 1). Together, they account for more than 50% of exploration expenditures in the region. Diamond drilling occurred on only 14 properties. The only major exploration project on an active minesite was at Mount Polley. A tally of Notice of Work (NoW) submittals for all types of projects in the region, shown in Table 2, shows a steady decline in the number of NoW processed

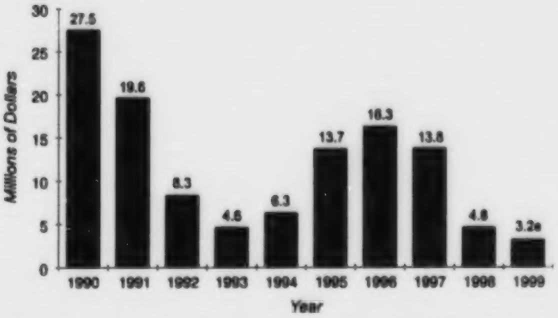

Figure 2. Annual Exploration Expenditures, Northeast-Central Region.

TABLE 1. MAJOR EXPLORATION PROJECTS, NORTHEAST-CENTRAL BRITISH COLUMBIA - 1999

Property (Owner)	MINFILE	NTS	Commodity	Deposit Type	Work Done
Lustdust (Alpha Gold)	093N 009	93N/11W	Au, Ag, Zn, Cu, Pb	skarn, manto	18 ddh, 3045 m
Cariboo Gold Quartz (International Wayside Gold Mines)	093H 019	93H/4E	Au	mesothermal vein	18 ddh, 1498 m; trench; geochem
Pine (Stealth Mining)	094E 016	94E/2E	Au, Cu	porphyry	3 ddh, ~800 m; prospect; geochem
Jake (Teck Exploration)	094D 061	94D/3W	Au	epithermal vein	6 ddh, 696 m; trench; geochem; geol
Chappelle - Baker mine (Sable Resources)	094E 026	94E/6E	Au, Ag, Cu	epithermal vein	15 ddh, 650 m; trench; geochem
Mount Polley (Imperial Metals)	093A 008	93A/12E	Au, Cu	porphyry	18 ddh, 4067 m; geol
Mosquito Creek (Island Mountain Gold Mines)	093H 010	93H/4E	Au	mesothermal vein	10 ddh, 902 m; 411 m u/g rehab
Tas (Omni Resources)	093K 080, 091	93K/16W	Au, Cu	porphyry	7 ddh, 653 m
Woodjam (Phelps Dodge)	093A 078, 124	93A/6W	Au, Cu	porphyry	4 ddh, 767 m
Willow Creek (Pine Valley Coal)	093O 008	93O/4E	coal	sedimentary	40 air rotary holes, incl. 159 m of coring; 2 tonne bulk sample

since 1995. During the year there were just 2112 new mineral claim units staked in the region, while 6269 units were either forfeited, canceled or abandoned. Gold-enriched porphyry copper deposits and gold vein systems continued to be the exploration targets of choice (Figure 4), together accounting for more than half of all exploration expenditures.

There was a modest improvement in the level of early-stage exploration activity (an estimated $1 million), but most programs had very limited budgets. However, several new discoveries were made that may have important regional implications. Of particular note are two new volcanogenic massive sulphide (VMS) prospects in the Cariboo. Prospectors Assistance Program grantees in the region located several new showings that warrant follow-up.

TABLE 2. NOTICE OF WORK SUBMITTALS FOR PROJECTS IN NORTHEAST-CENTRAL BRITISH COLUMBIA.

Type of NoW	**Year**				
	1995	**1996**	**1997**	**1998**	**1999**
Mineral	221	184	164	115	86
Placer	498	440	415	407	404
Coal	3	4	5	5	2
Other	67	58	57	56	42
Total NoW	**789**	**686**	**641**	**583**	**534**

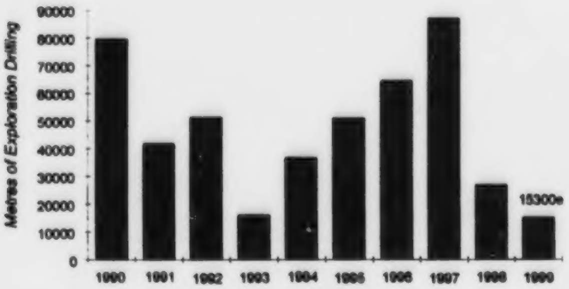

Figure 3. Annual Exploration Drilling, Northeast -Central Region.

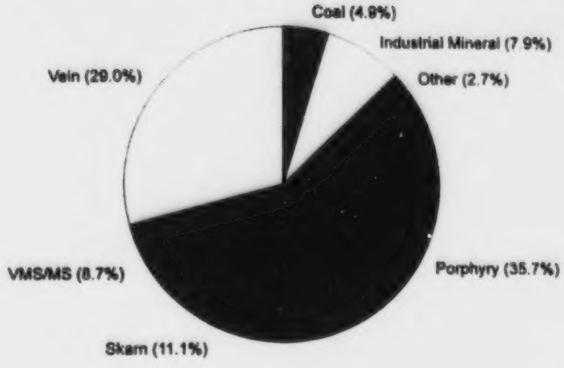

Figure 4. Exploration targets expressed as a percentage of total 1999 expenditures ($3.2 million) in northeast-central British Columbia.

EXPLORATION SUMMARY

GATAGA/KECHIKA TROUGH

For the second year in a row there were no exploration projects conducted in the prospective Gataga sedex lead-zinc silver belt.

TOODOGGONE CAMP

Exploration activity in the Toodoggone region consisted of three main projects, all located north of the Kemess mine.

Furthest north, at the **Baker** mine, Sable Resources Ltd. focused on the Ridge zone (Photo 3), an area immediately north and east of the mined A vein. The company was searching for the source(s) of two bonanza-grade epithermal gold-silver float trains that produced grab samples grading up to 550 g/t Au and 14 600 g/t Ag. Trenching and diamond drilling identified a number of intense argillic alteration zones within intensely oxidized and fractured andesitic flows of the Triassic Takla Group. Several of the alteration zones contain quartz stockworks and/or narrow quartz veins, but assays so far have been low. Late in the program the Beck vein was discovered. The 1.5-metre wide quartz-sulphide vein was exposed by trenching for 30 metres along strike. Trench samples of the Beck vein graded up to 3.6 g/t Au and 6.5 g/t Au. An aggressive follow-up exploration program, including more trenching and diamond drilling, will proceed in 2000.

Twenty-five kilometres north of the Kemess mine, Stealth Mining Corporation resumed its diamond drilling program on the **Pine** prospect, an Early Jurassic porphyry copper-gold system within volcanic and coeval intrusive rocks of the Toodoggone Formation.

Photo 3. Trenching of clay-altered Takla Group volcanic rocks on the Ridge zone, Baker mine.

Mineralization in the Pine zone comprises quartz-sericite-magnetite stockwork and associated pyrite-chalcopyrite, within propylitic and potassically altered monzonite to quartz monzonite. A three-hole drill program on the southeast part of the porphyry system targeted narrow, subvertical high-grade gold-bearing structures discovered by drilling in 1997 and 1998 (i.e. hole P97-4 graded 0.32% Cu and 215.9 g/t Au over 1.3 metres). A fourth hole designed to test the margin of the Tree zone, another porphyry copper-gold zone east of Pine, did not proceed because of lack of funds. In addition to the drilling program, Stealth undertook a regional prospecting and sampling program to re-evaluate a number of known epithermal prospects, such as Goat, Nub and Electrum/Beaverpond, the Northwest Breccia porphyry showing and the JC 20-unit claim.

Finlay Minerals Ltd. cut 11.25 kilometres of grid and completed IP and magnetometer surveys, mapping and soil and rock geochemistry on its **Pil** porphyry copper-gold prospect immediately north of the Pine property in the Toodoggone. The property is underlain by Lower Jurassic quartz-bearing Toodoggone volcanics and genetically associated intrusions. Typical alteration is of the pyrite-sericite type. Three anomalous areas, characterized by coincident geochemical and geophysical anomalies, were outlined: South Pil, a northwest-trending zone, measuring 1500+ by 500 to 800 metres, that contains showings of quartz-chlorite alteration accompanied by chalcopyrite and is characterized by a broad, deep-seated IP anomaly; Central Pil, an area of faulted contact between Lower Jurassic volcanics and intrusions that has yielded two 600 ppb Au rock samples, and; North Area, where widespread sericite-pyrite alteration is associated with strongly anomalous gold values in soils within a northerly trending zone, 550 metres long by 250-700 metres wide. Although generally at an early stage of exploration, several of the targets are ready for drilling.

OMINECA MOUNTAINS

Phelps Dodge Corporation of Canada Ltd. continued its evaluation of the Car, Rut and Pass volcanogenic massive sulphide properties in the **Carruthers Pass** area, 75 kilometres north of Takla Lake. The properties are underlain primarily by shale, siltstone and andesitic tuff of the Dewar Formation (Upper Triassic Takla Group). Contour and grid-based soil sampling outlined several copper-zinc anomalies and led to the discovery of a copper-rich shale horizon exposed in rugged northwest-facing cliffs on the Rut claims. The stratabound zone has been traced for more than 700 metres along its northwesterly strike. Grabs samples of stringer and bedded pyrite-chalcopyrite mineralization grade up to 5.3% Cu, 0.4% Zn and 702 g/t Ag. A follow-up ground magnetometer survey was completed in 1999, and together with additional mapping, prospecting and geochemical sampling, has identified more anomalies that require further evaluation. A large blocky showing of banded massive sulphide mineralization on the Rut property, sampled in 1998 (3170 ppb Au, 250 g/t Ag, 4.44% Cu and 3.48% Zn), was proved to be float; however, its source was confirmed to be the cliffs directly upslope. Diamond drilling will likely test the sulphide-bearing horizon in 2000.

Doublestar Resources Ltd. acquired the **Sustut** volcanic-redbed copper deposit, located in the Upper Sustut River drainage, from Falconbridge Ltd. Doublestar plans to conduct infill drilling in 2000 on the gently dipping tabular deposit to prove up a mineable reserve from the existing open pit resource of approximately 21 million tonnes grading 1.11% Cu.

North of the Osilinka River, 50 kilometres northwest of Germansen Landing, Steve Fulbrook and partners began the construction of a 4-5 ton per hour crushing, milling and gravity separation pilot plant on their **Osilinka** property. They plan on to produce a precious metal rich sulphide and sulphosalt concentrate from several different ore types that will be processed off site. Underlying rocks are shale, argillite, sandstone and felsic tuff of the Devonian to Permian Big Creek group and several mafic to ultramafic bodies of Triassic to Jurassic age. Little is known of the style of mineralization.

Further south in the Swannell Ranges, Lysander Gold Corp. completed a prospecting and sampling program on the **Jajay (Lorraine)** property, a large alkalic porphyry copper-gold prospect northwest of Germansen Landing. The program was successful in identifying targets for follow-up next year (previously identified PGE stream sediment anomalies).

HOGEM RANGES

At the **Lustdust** property, located north of Kwanika Creek, about 36 kilometres northeast of Takla Landing, Alpha Gold Corp. conducted the largest off-minesite diamond drilling program in the region. The property is west of the Pinchi fault and is underlain by limestone and mafic tuff of the Permian Cache Creek Group. A poorly exposed monzonite stock and related feldspar megacrystic dikes and sills, part of the Hogem batholith, cut stratigraphy and are at least spatially related to the development of hornfels and previously explored proximal copper-gold skarns, zinc-rich mantos (Photo 4) and distal silver-gold-lead-zinc veins.

The 18-hole, 3045-metre drilling program accomplished two objectives. It extended the strike length of the skarn zone 1000 metres further to the north (e.g. hole LD99-06 intersected 5.2 metres grading 8.3% Cu) and provided very encouraging information on a previously untested 400-metre gap between the most southerly skarn holes and most northerly exposures of manto mineralization. One of the most encouraging assays was from hole LD99-17 that intersected 5.8 metres of sphalerite-rich, manto-style mineralization grading 772 ppb Au, 0.9% Cu and 18.9% Zn. The northwesterly trending mineralized system is about 2500 metres long and 500 metres across. Future exploration will continue to examine the metal zonation, tenor and size of the mineralized system.

Photo 4. Exposure of sphalerite-rich, manto-style mineralization, Lustdust property.

SKEENA RANGES

Teck Exploration Ltd. completed a diamond drilling and trenching program on the **Jake** epithermal gold prospect located in the Skeena Ranges, 105 kilometres north of Hazelton. The ground had previously been evaluated in the early to mid-1970s for its porphyry copper potential. In 1998, grids were established on either side of a prominent east-trending fault. Soil sampling and bedrock mapping outlined target areas on the North Jake grid, characterized by argillic alteration and a Ag-Cu-Mo-Pb-Zn±Au geochemical signature, and South Jake grid, outlined by a Au-Bi-As-Cu±Ag geochemical signature. Six holes were drilled on the Jake North target, while over 500 metres of trenching was completed at Jake South. Classic epithermal mineralization is spatially associated with a swarm of north-trending Tertiary(?) monzonite and quartz monzonite dikes that intrude fine-grained sediments and volcaniclastics of the Middle to Upper Jurassic Bowser Lake Group. Assay results have not been released by the company.

NATION LAKES AREA

Omni Resources Inc. completed a seven-hole diamond drilling program on its **Tas** gold property, located near Inzana Lake, 65 kilometres north of Fort St. James. The property encompasses the Freegold, East, Mid 21, 19 and West zones. The mineralized system, comprised of a series of gold-bearing sulphide and magnetite veins within a northwest-trending shear zone cutting volcaniclastics of the Inzana Formation (Triassic Takla Group), was discovered by A.D. Halleran in 1984. In 1993, he extracted bulk samples from the A and B veins, part of the East zone, recovering a total of approximately 1000 grams of gold from the processing of 32 tonnes of mineralized material. Drilling by Omni in 1999 targeted a 900-metre long, west-trending feature defined by a strong IP anomaly and anomalous gold in soils. The best intersection was from hole TAS99-5 that averaged 13.23 g/t (0.386 oz/ton) gold over 2.32 metres.

ROCKY MOUNTAIN FOOTHILLS

Pine Valley Coal Ltd. continued to evaluate its **Willow Creek** coal property, 45 kilometres west of Chetwynd. The deposit occurs on the north limb of the Peace River anticline, within the Cretaceous Gething Formation. Eight major seams, with a combined thickness of 21 metres comprise the coal deposit. In 1999, a two-phase program of infill drilling, consisting of 24 shallow, air-rotary holes totaling approximately 660 metres, was completed in the Central Pit area. An additional 16 holes, in two clusters, cored 159 metres of low-volatile coal from seam 7, in an area of the Central Pit with a low strip ratio. The drilling yielded approximately 2 tonnes of sample for test marketing. The low-ratio area is slated for a permitted 50 000-tonne bulk sample in 2000. The 2 to 3 month project, is budgeted to cost in excess of $2 million.

Western Canadian Coal Corporation conducted limited survey work on its **Belcourt** coal property, 85 kilometres south of Tumbler Ridge, and completed a preliminary feasibility study on the deposit. The company also holds licenses over the previously explored **Saxon** and **Burnt River** coal properties. The Burnt River property, 50 kilometres south of Chetwynd, covers a low-volatile coal resource that is suitable for a number of markets. A Notice of Work, approved in late 1999, outlines a drilling and sampling program that will evaluate selected coal seams for marketing.

NECHAKO PLATEAU

For the first year in quite some time there were no diamond drilling programs in the Nechako Plateau region. In fact, with the exception of a very modest amount of prospecting that targeted epithermal gold, porphyry copper-gold and precious opal deposits, there was no activity.

COLUMBIA MOUNTAINS

An investigation of the **Kendall** copper-bearing structure, in the northern Columbia Mountains, 45 kilometres northwest of McBride, was carried out by owner Trent Lemke. The northwest-trending structure is the faulted contact between Windermere Yankee Bell and Midas formations. The zone has a minimum strike length of 1.2 kilometres and ranges in width from 4 to 9 metres. Mineralization is associated with quartz-carbonate flooding of the structure. Chalcopyrite is the principal copper sulphide; chalcocite occurs locally and is associated with modest silver grades. Pyrite is common, particularly in deformed phyllites (Midas) that are caught up in the structure. A 2.95-metre channel sample across part of the mineralized structure averaged 2.54% Cu. Grab samples have assayed up to 14% Cu with as much as 8 g/t Ag.

Trent Lemke also systematically sampled a series of auriferous en echelon veins on the **Milk** property, 25 kilometres west of McBride. The veins occur in pervasively iron carbonate altered and deformed phyllites (Isaac Formation) and feldspathic sandstones and grits (Kaza Group). The main exposure is about 200 metres across with a vertical component of 100 metres. Veins are comprised mainly of white 'bull' quartz and pyrite with minor amounts of chlorite, ankerite and sericite. Gold grades are erratic, ranging up to 66 g/t Au in grab samples.

CARIBOO

Exciting discoveries and/or developments of two new volcanogenic massive sulphide (VMS) prospects highlight exploration in the Cariboo and have significant regional implications. A re-evaluation of prospective VMS belts including the Slide Mountain Terrane (Antler Formation) and Barkerville Terrane (Snowshoe Group) is warranted.

The **Lottie** VMS float prospect, 15 kilometres north of Wells, was discovered and staked in 1998 by Martin Peter, with support from the province's Prospectors Assistance Program. The claims, underlain by cherty argillite and basalt of the Paleozoic Antler Formation (Slide Mountain Terrane), were optioned to Eureka Resources Inc. later that year. In 1999, the company conducted a modest program that included soil and till geochemical sampling, a VLF electromagnetic survey, a glacial till fabric study and test pitting. Test pitting of the high-grade float area did not locate its bedrock source, but did uncover many angular blocks of massive sulphide mineralization from a 2 to 2.5-metre depth that assayed up to 24% Cu. A grab sample of pyrite-rich massive sulphide assayed 1.03% Cu, 240 ppb Au and 0.06% Co. In late November, Eureka optioned its 850-unit property, that encompasses Lottie and two other VMS float prospects discovered by Martin Peter, the **Bow** and **Tow**, to Hudson Bay Mining and Smelting Co. Ltd., an affiliate of Anglo American Plc. Hudson Bay plans a $400 000 exploration program in 2000, consisting of airborne and ground-based geophysical surveys, geochemistry, geological mapping and diamond drilling. Renewed interest in this area north of Wells may result in a regional-scale re-examination of the potential of the Slide Mountain Terrane. Other VMS showings are known to occur in Slide Mountain rocks, including **Nina**, in Nina Creek Group stratigraphy north of Germansen Landing.

East of Cariboo Lake, Barker Minerals Ltd. continued prospecting and sampling areas of its large **Ace** property. In June, massive sulphide float was located in a road cut near **Frank Creek**. A sample comprised of several cobbles of oxidized massive sulphide assayed 2.02% Cu, 305 ppb Au, 1.16% Pb and 0.94% Zn. Trenching exposed a bed of massive sulphide mineralization in excess of 1.2 metres thick. It is composed mainly of fine-grained pyrite with local disseminations and whispy bands of chalcopyrite, pale brown sphalerite and galena. Fractures and a foliation-parallel fabric contain coarser grained base metal sulphides with silica±chlorite. Enclosing rocks are an overturned package of phyllitic argillites, reworked felsic pyroclastics and pillow basalts mapped as part of the Paleozoic Snowshoe Group (Harveys Ridge succession) by Struik. A 1.2-metre (true width) channel sample assayed 0.65% Cu, 0.14 g/t Au, 69 g/t Ag, 0.12% Pb and 0.10% Zn. In addition to the main bed, numerous small lenses of massive sulphide, up to 10 centimetres thick, were noted.

Barker Minerals also discovered a bed of sulphide-bearing limy quartzite, 2 to 3 metres thick, sandwiched between grey limestone, north of **Sellers Creek**. A grab sample from the showing, containing about 2% disseminated chalcopyrite-sphalerite-galena, assayed 3920 ppm Cu, 1850 ppm Pb and 838 ppm Zn.

At the **Grizzly Lake** zinc-lead prospect, 20 kilometres east of Cariboo Lake, Golden Kootenay Resources Inc. drilled four holes to test two prominent gravity anomalies. The property is in the Cariboo Terrane and is underlain primarily by dolomitized and recrystallized limestone of the Hadrynian Cunningham Formation, Cariboo Group. The gravity anomalies are spatially associated with spectacular zinc-lead sulphide and carbonate mineralization that commonly occurs with a quartz gangue in stringers, stockworks and zones of dilational crackle breccia. Drilling did not intersect any significant zones of mineralization.

International Wayside Gold Mines Ltd. continues to explore the former **Cariboo Gold Quartz** mine at Wells. The mine operated from 1933-1967, producing 26.85 million grams (863 305 oz) of gold from 1.95 million tonnes of ore. Most of the ore was mined from mesothermal veins in phyllitic rocks of the Snowshoe Group. In January, 1999, the company announced a revised geological reserve (based on surface and underground drilling it completed from 1996 to 1998) for the Sanders-Rainbow-Pinkerton zone of 6.75 million tonnes grading 4.6 g/t (0.135 oz/ton) Au at a cutoff grade of 1.03 g/t (0.03 oz/ton) Au. During the 1999 field season, 18 diamond drill holes totaling 1498 metres targeted the nearby BC vein, a northwest-trending, steeply northeast dipping vein that crops out on the southwest side of Barkerville Mountain. It has an average width of approximately 2 metres and a strike length of at least 750 metres. The auriferous vein (Photo 5) is comprised mainly of white 'bull' quartz with up to 30% coarse-grained pyrite and up to 5% pale orange iron carbonate. Free gold is uncommon, but was observed in a core specimen from hole 99-09. The best assay is from hole 99-04 that intersected 5.0 metres of vein averaging 14.43 g/t gold (0.421 oz/t). Systematic drilling enabled the company to complete a resource calculation for a 230-metre section of the vein between the BC shaft and the Goldfinch fault, which totaled 55 800 tonnes grading 9.8 g/t (0.287 oz/ton) Au for 550 000 grams of contained gold. Evaluation of the vein is expected to continue in 2000. International Wayside is proceeding with its plans to enter the Environmental Assessment process.

Island Mountain Gold Mines Ltd. is in the process of earning a 50% interest in the former **Mosquito Creek** mine, immediately north of Wells, from International Wayside Gold Mines Ltd. A nine-hole, 811-metre surface diamond drilling, west of the Mosquito fault, was completed. Rehabilitation of the old Level 1 (4400 level) adit, a 411-metre tunnel with crosscuts and stopes developed in 'Main Band' limestone, host to pyrite-replacement ore, was initiated. A previously sampled quartz-pyrite vein, averaging 1.4 metres in width, assayed up to 61.7 g/t (1.8 oz/ton) Au. Surface drilling targeted the extension of this vein as well as pyrite-replacement mineralization, beyond the extent of the underground development. The best assay was from hole IMG-99-08 that intersected 8.23 metres of vein mineralization averaging 14.06 g/t Au.

Big Valley Resources Ltd. drilled five rotary holes on its Hugger claim group, immediately south and west of the QR mine, to follow up on several copper-gold anomalies identified last year. The Hugger claims are part of the company's **Lloyd-Nordik** property, that

Photo 5. Drill-core intersection of the BC vein, showing coarse-grained pyrite in a gangue of white quartz.

covers a number of porphyry copper-gold prospects and showings associated with Early Jurassic alkalic intrusions. Results are not yet available.

Near Jacobie Lake, Jack Stoch completed 230 metres of trenching to further expose flow-top copper mineralization on the **Jacobie Lake** prospect.

Phelps Dodge Corporation of Canada Ltd. drilled four NQ holes on its **Woodjam** property, located approximately 7 kilometres southeast of Horsefly. The company was targeting a previously drilled Early Jurassic alkalic porphyry gold-copper system. Hole 99-20 returned an intersection averaging 0.85 g/t Au and 0.13% Cu over 80 metres within a 144 metre intercept, starting at a depth of just 2.4 metres, that graded 0.72 g/t Au and 0.12% Cu.

Also in the vicinity of Horsefly, partners Herb Wahl and Jack Brown-John completed limited trenching and test pitting on their **Dot Com** and **Rodeo/Luky Jack** flow-top / porphyry copper prospects.

PROSPECTORS ASSISTANCE PROGRAM

The Prospectors Assistance (PA) program awarded grants of up to $10 000 to support seven grassroots exploration projects in the northeast-central region in 1999 and there were some encouraging discoveries. Lorne Warren located several massive sulphide boulders within a copper-zinc-arsenic soil anomaly and a broad zone of intense albitization (Whiterock showing) near his **Vent** and Diver Lake properties north of Takla Lake, an area underlain by Paleozoic to lower Mesozoic rocks of the Sitlika assemblage (Kutcho Formation equivalent). Bill Poole discovered a coarse-grained wollastonite showing of uncertain dimensions along the margin of a granodiorite stock on his **Murray** claim south of the Blackwater River.

ACKNOWLEDGMENTS

This report is a compilation of information collected from property visits by the Regional Geologist and other Prince George Mines Branch staff. Information generously provided by the mining, exploration and prospecting community throughout the region is gratefully acknowledged and makes the compilation of this report possible. Ken MacDonald summarized placer activity in the region and, together with Ed Beswick, and John Newell, critically reviewed the manuscript.

SOUTHWESTERN REGION

by R. H. Pinsent, P. Geo.

Research Geologist, Vancouver

HIGHLIGHTS

- Boliden Westmin (Canada) Limited ceased production at its Myra Falls operation, near Campbell River, for a few months over the winter (1998-1999) while completing a planned rehabilitation program and developing a long term strategic mine plan.
- Quinsam Coal Corporation closed its thermal coal mine, also near Campbell River, in May and sought creditor protection. It reopened at reduced capacity in June and, in January, 2000, the corporation proposed a financial restructuring package.
- GTN Copper Technology Limited announced plans to build a hydrometallurgical plant to process copper concentrate at the former Island Copper mine site, near Port Hardy.
- Doublestar Resources Limited acquired Falconbridge Limited's interests in several properties in the region including the Catface porphyry copper and the Chemainus and Baldwin/McVicar volcanogenic massive sulphide prospects.

EXPLORATION AND PRODUCTION TRENDS

Exploration activity was down in the region in 1999, as it was throughout the province. There were eleven major projects (defined as significant drilling or trenching programs or projects likely to have incurred costs in excess of \$100 000), up from ten in 1998 (Figure 1). However, estimated expenditure was down to \$4.0 million, appreciably less than the \$6.0 million spent the previous year (Figure 2). As there were \$2 to \$3 million programs at Boliden Westmin's Myra Falls operation both years, the amount attributable to other projects has dropped to \$2 to \$3 million, far less than was typically spent in the early 1990s. The amount of drilling reported also decreased in 1999, to approximately 17 500 metres (Figure 3).

The locations of major mines, quarries and exploration projects in the region in 1999 are shown on Figure 4. There are two active metal mines, two major quarries and several small industrial mineral operations.

Table 1 lists the major exploration projects in the region. Several smaller programs are also referred to in the text. The projects active in 1999 show continued interest in exploration for higher grade vein and massive sulphide (volcanogenic and skarn) deposits and high-quality industrial minerals.

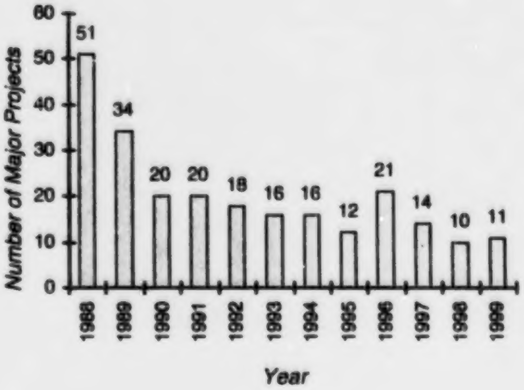

Figure 1. Number of major exploration projects per year, Southwestern Region. Note that the Queen Charlotte Islands were transferred to the Northwest Region in 1996.

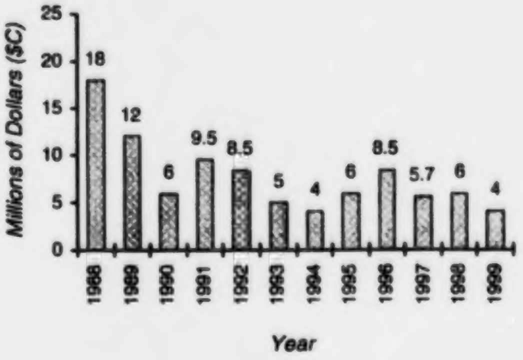

Figure 2. Annual exploration expenditure, Southwestern Region. Note that the Queen Charlotte Islands were transferred to the Northwest Region in 1996.

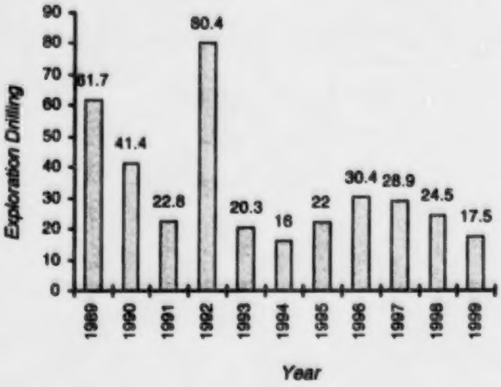

Figure 3. Annual exploration drilling, Southwestern Region (in thousands of metres). Note that the Queen Charlotte Islands were transferred to the Northwest Region in 1996.

The tonnage and value of solid mineral production in the region dropped in 1999, as the two major mines responded to reduced commodity prices by implementing temporary closures. Boliden Westmin (Canada) Limited ceased production at Myra Falls in December, 1998 for a planned period of drift and stope rehabilitation and underground development. It resumed production in March, 1999. Despite restructuring its operation and reducing costs in 1998, Quinsam Coal Corporation closed its coal mine at Campbell River in May, 1999, while seeking creditor protection. It resumed production a few weeks later, albeit at a much reduced rate.

The industrial mineral and sand and gravel suppliers appear to have held their own in 1999. Total production of limestone, dimension stone and construction aggregate either remained similar to the previous year, or decreased slightly. There was; however, increased production of some specialized commodities such as silica and decorative stone.

An Australian company, GTN Copper Technology Limited, announced that it is studying the feasibility of producing refined copper at the former Island Copper mine site, near Port Hardy. It plans to build a plant to leach copper, gold and silver from concentrate and recover it by electrolysis. The concentrate will be shipped to the site from mines in western Canada, the United States and South America. If the project comes to fruition, the operation would likely process approximately 50 000 tonnes of copper concentrate annually at start up. However, that could increase to 200 000 tonnes within a few years.

PRODUCING MINES AND QUARRIES

In addition to the two mines and two major quarries (Myra Falls, Quinsam, Gillies Bay and Blubber Bay), there are several large sand and gravel operations and numerous small industrial mineral producers in the region. These include IMASCO Minerals Inc., limestone; Monteith Bay Resources Ltd., silica; I.G. Machine and Fibers Ltd., limestone; Great Pacific Pumice Inc., pumice; Garibaldi Granite Group, dimension stone and Clayburn Industries Ltd., clay. While some of these operations are long-standing and mature, others are recent developments with considerable potential for growth in the years ahead.

MYRA FALLS OPERATION

Boliden Westmin (Canada) Limited mines a series of large, geologically complex, volcanogenic massive sulphide deposits in Sicker Group rocks at the south end of Buttle Lake, near Campbell River. The operation has a nominal mill capacity of 3850 tonnes per day and a staff of approximately 450 people.

Because of its closure in early 1999, production was down 30% from the previous year. The company milled 739 700 tonnes of ore grading 1.63% Cu, 5.68% Zn, 1.55 g/t Au and 19.84 g/t Ag and reported production of 10 397 tonnes of copper, 37 861 tonnes of zinc, 421 850 grams of gold and 6 376 115 grams of silver. During the winter, some of the stopes were back-filled and stabilized and work continued to improve access to the Battle/Gap area. The mine resumed production, at slightly below design capacity, at the end of March.

As of January, 2000, Myra Falls reported a proven and probable mining reserve of 7 719 964 tonnes grading7.3% Zn, 1.4% Cu, 0.5% Pb, 1.4 g/t Au and 38.9 g/t Ag, an increase of slightly less than 1.0 million tonnes. Approximately 3.5 million and 0.84 million tonnes of reserves are in the Battle and Gap zones, respectively and a further 2.1 million tonnes are in the H-W zone. There are also 0.91 million tonnes in the 43-Block zone and 0.4 million tonnes in the Extension zone. The mining reserve is sufficient for approximately seven years of full-scale production but that considerably understates the probable life of the mine. There is a substantial geological resource in need of definition drilling and considerable potential for new discoveries along trend to the west.

In 1999, the company diamond drilled 27 holes from underground workings, for an aggregate length of 13 173 metres. Most were long (> 700 metre), in-fill holes, collared on 10 level of the Lynx mine and angled to intercept the Marshall zone, a relatively recent discovery on the north flank of the productive area. The zone is poorly-delineated but it appears to be a zinc-rich deposit that is intimately associated with a barite unit that has

TABLE 1. MAJOR EXPLORATION PROJECTS, SOUTHWESTERN REGION, 1999

Property (Owner)	MINFILE	Mining Division	NTS	Commodity	Deposit Type	Work Done
Blubber Bay (Ashgrove Cement Company)	092F 479	Nanaimo	92F/15E	Limestone		9 ddh, 550 m
Davie Bay/Grilse Point (Tilbury Cement Ltd.)	092F 104 092F 471	Nanaimo	92F/9W 92F/15E	Limestone		6 ddh, 180 m 7 ddh, 420 m
Duck Lake (Homegold Resources Ltd.)		Vancouver	92F/16W	Clay		4 ddh, 300 m
Fandora (Doublestar Resources Ltd.)	092F 041	Alberni	92F/4E	Au,Ag,Cu	Vein	bulk sample
Mactush (SYMC Resources Ltd.)	092F 012 092F 103	Alberni	92F/2W	Cu,Au,Ag	Vein	trenching
Myra Falls (Boliden Westmin (Canada) Ltd.)	092F 330 092F 073	Alberni	92F/12E	Cu,Zn,Au,Ag	Massive Sulphide	27 u/g ddh, 13 173 m 13 ddh, 929 m
Stan (Lorex Minerals Inc.)	092JW008	Vancouver	92J/3E	Au,Ag,Cu,Pb	Vein/skarn	5 ddh, 500 m
Tay (Dalmation Resources Ltd.)	092F 212	Alberni	92F/6W	Fe,Cu,Au	Vein/skarn	5 ddh 450 m
Valentine Mountain (Beau Pre Explorations Ltd.)	092B 108	Victoria	92B/12W	Au	Vein	2 ddh, 400 m
Vulcan (TDB Forestry Services Ltd.)	092JW039	Vancouver	92J/11W	Pumice		trenching
Yreka (Talltree Resources Ltd.)	092L 052	Nanaimo	92L/5E	Cu,Mo,Ag,Au	Skarn	geology, geophysics geochemistry

produced some of the highest grade gold and silver intercepts so far found in the mine. Preliminary data indicate a resource of approximately 320 000 tonnes averaging 7.6% Zn, 0.7% Cu, 0.7% Pb, 2.5 g/t Au and 105.6 g/t Ag. The company plans to reopen and rehabilitate 15 level in the Lynx mine and drive a crosscut above the zone to provide access for closer spaced drilling.

Elsewhere, the company drilled four relatively deep (400 to 500 m) holes into the footwall of the H-W deposit, looking for evidence of stacked mineralization in or below the andesite of the underlying Price Formation. The results were disappointing as there was no indication of felsic rock to the depth drilled and the mineralization was largely comprised of a quartz-pyrite vein stockwork.

The company diamond drilled 13 surface holes, totaling 929 metres, to delineate the M zone, below the floor of the Lynx pit. A small but high-grade, polymetallic and precious metal rich lens was defined, similar in composition to the nearby Myra deposit that was mined from 1972 to 1985. The lens is readily accessible and may be mined in 2000.

QUINSAM COAL MINE

Hillsborough Resources Limited has a (63%) interest in a small underground coal mine, near Campbell River, operated by Quinsam Coal Corporation. In the mid-1990s, Quinsam Coal switched from open-pit to underground mining and expanded production to achieve economies of scale. It doubled the capacity of its wash - plant,

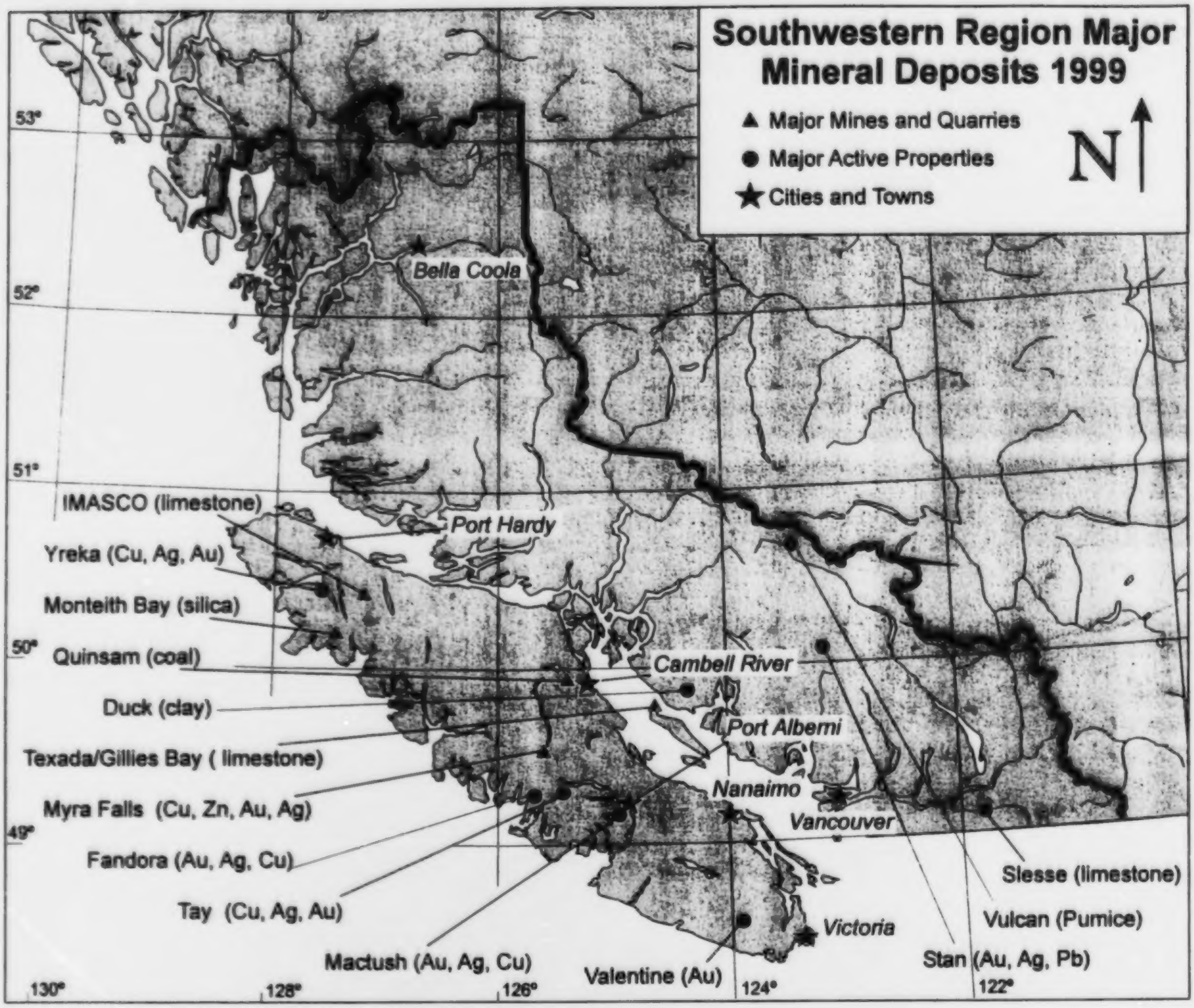
Southwestern Region Major Mineral Deposits 1999
▲ Major Mines and Quarries
● Major Active Properties
★ Cities and Towns
N
53°
52°
51°
50°
49°
130°
128°
126°
124°
122°
Bella Coola
Port Hardy
Cambell River
Port Alberni
Nanaimo
Vancouver
Victoria
IMASCO (limestone)
Yreka (Cu, Ag, Au)
Monteith Bay (silica)
Quinsam (coal)
Duck (clay)
Texada/Gillies Bay (limestone)
Myra Falls (Cu, Zn, Au, Ag)
Fandora (Au, Ag, Cu)
Tay (Cu, Ag, Au)
Mactush (Au, Ag, Cu)
Valentine (Au)
Stan (Au, Ag, Pb)
Vulcan (Pumice)
Slesse (limestone)

Figure 4. Major mineral deposits, Southwestern Region, 1999

developed new production sites and installed several new "continuous miners". The changes increased the capacity of the operation from 250 000 tonnes to approximately 1.2 million tonnes of high-quality, clean, bituminous, thermal coal per year.

Both companies incurred considerable debt upgrading the mine and were poorly placed to cope with the drop in the price of coal that occurred in 1998. Quinsam Coal cut staff and reduced production in July that year. However, its financial difficulties continued and in May, 1999, it closed the mine and sought protection under the Companies' Creditors Arrangement Act. After several months of negotiation, in January, 2000 the companies applied to the courts for permission to present a financial restructuring plan to creditors and shareholders.

Quinsam Coal reopened the 2N block at the mine, in June, to meet the needs of local customers, including some of the cement plants in the Lower Mainland. Total production of clean coal during the year was down to 361 571 tonnes.

Hillsborough Resources has an interest in T'Sable River Coal Corporation, which controls an undeveloped coal deposit in similar rocks south of Courtenay. The company has the necessary approvals to drive an adit and extract a bulk sample when economic conditions improve. There was no exploration or development drilling at Quinsam or T'Sable River in 1999.

LIMESTONE QUARRIES

Texada Quarrying Limited (formerly Holnam West Materials Limited) and Ashgrove Cement Limited are the largest suppliers of limestone in the Pacific Northwest. Between them, they produce approximately 5.0 million tonnes of chemical, cement, agricultural and crushed rock (aggregate) limestone annually from quarries at Gillies Bay and Blubber Bay, on Texada Island.

Total demand for limestone has been fairly stable over the past few years, but the requirement for limestone as construction aggregate was down in 1999, as a result of reduced over-all economic activity. The amount of cement-grade limestone produced had been expected to increase in 1999, as Lafarge Canada Inc. brought its upgraded cement plant in Richmond on stream in June. However, the increase did not materialize because demand for cement was down and the plant started production at considerably below design capacity.

In 1998, Lafarge purchased the Gillies Bay quarry from Holnam West Materials Limited to ensure access to suitable cement-grade limestone. In 1999, it completed a review of its newly acquired operation and produced a 30-year mine development plan.

Ashgrove Cement carried out a limited diamond drill program following up on a chemical-grade limestone drill intercept 1500 metres northeast of its producing quarry at Blubber Bay. Nine holes for an aggregate depth of 5500 metres were diamond drilled.

Tilbury Cement Limited, the other major cement producer in the Lower Mainland, currently purchases limestone from Lafarge's Gillies Bay operation. However, it has its own quarry, at Grilse Point, that it could reactivate and a site, near Davie Bay, that it could also develop. In 1999, the company diamond drilled six holes at Grilse Point for a total depth of about 180 metres, and seven holes at Davie Bay for an aggregate depth of about 420 metres. The results are being used for quarry modeling.

Imperial Limestone Corporation produces approximately 220 000 tonnes of chemical-grade limestone annually from a smaller quarry on Texada Island. The product is shipped to Seattle where it is used as an industrial filler. Chemical Lime of Canada Limited holds tenures over similar, chemical-grade, limestone on Texada Island but it does not, as yet, have a producing quarry. It proposed a three-hole diamond drilling program in 1999, but later deferred it until 2000.

IMASCO Minerals Inc. produces approximately 40 000 tonnes of bright white limestone annually from a quarry at Benson Lake on Vancouver Island. The product is also used as a commercial filler.

I.G. Machine and Fibers Limited opened a limestone quarry near Slesse Creek in the Chilliwack valley in 1998, and shipped 34 000 tonnes to its newly commissioned asphalt shingle plant at Sumas, in Washington State. In 1999, it quarried an additional 50 000 tonnes and shipped approximately 20 000 tonnes. Despite some early concerns over the quality of the limestone, demand for the product is expected to increase as the asphalt operation expands.

DIMENSION STONE QUARRIES

There are several rock processors in the Lower Mainland area and on Vancouver Island that use local material. Most of it comes from small quarries that are worked on a seasonal basis, as and when required.

Margranite Industries, a local tile-maker, obtains dimension stone blocks from an affiliate, Quarry Pacific Industries Limited, Quarry Pacific owns three quarries, two of which (Skagit valley and Anderson valley) are within the region. In 1999, they produced approximately 400 cubic metres of stone.

Other processors purchase rock from suppliers who ship blocks into the Lower Mainland from quarries located around the coast. Granite Island Quarries Limited and Hardy Island Granite Limited barged in rock from the Jervis Inlet area. Matrix Marble Limited and Tsitika Stone Industries Limited produce and process rock on Vancouver Island.

Garibaldi Granite Group opened a processing plant in Squamish a few years ago. The company produces split-faced cut blocks and other specialty products for the construction industry. Its principal sources of supply include quarries in Squamish and in the nearby Ashlu River valley. Huckleberry Stone Supply Limited also produces stone in the Squamish area. It produces up to 7000 tonnes of basalt annually for sale as uncut decorative stone.

OTHER INDUSTRIAL MINERALS

The number and variety of small-scale industrial mineral producers in the region continues to increase and will probably continue to do so.

Clayburn Industries Limited is a long-standing industrial mineral producer and manufacturer. It produces approximately 25 000 tonnes of clay annually from a series of pits on Sumas Mountain, in the Fraser Valley. Some of the clay is used in the manufacture of specialty refractory products that are sold world wide and the remainder is used to produce face bricks. With a partner, Clayburn also produces clay for the cement industry.

Monteith Bay Resources Limited, a subsidiary of Tilbury Cement Limited, is a relatively new producer.

Although it has had production permits for several years, it made its first major shipment of 37 100 tonnes of "geyserite" silica in 1999. The product was barged to Tilbury's cement plant in Delta from a seasonal quarry at Easy Inlet, on the west side of Vancouver Island.

Great Pacific Pumice Inc. has also had production permits for several years. However, it has had to function without the benefit of a fully established processing plant and it has produced at a relatively modest rate. In 1999, it produced approximately 8500 cubic metres of pumice from its seasonal quarry at Mount Meager, north of Pemberton. The material is used for horticultural applications and as light-weight fill for the construction industry.

EXPLORATION ACTIVITY

VANCOUVER AND INSHORE ISLANDS

YREKA (MINFILE 092L 052)

Talltree Resources Limited explored the past-producing Yreka copper property, west of Neroutsos Inlet. The property covers numerous, widespread, copper skarn showings and prospects, one of which was developed into a small underground mine in the late 1960s. Yreka Mines Limited produced approximately 137 000 tonnes grading 2.87% Cu, 33.1 g/t Ag and 0.36 g/t Au between 1965 and 1967. The other named showings are relatively unexplored and the area was prospected for large-tonnage copper skarn and/or porphyry copper-molybdenum deposits.

In 1999, Talltree Resources conducted detailed mapping, geophysical and geochemical programs around the Upper Blue Grouse, Tuscarora and North Arm prospects. The Upper Blue Grouse occurrence is on strike with the main mineralized skarn unit at Yreka. It is several kilometres to the southeast of the mine. The Tuscarora showing is several kilometres to the north of the Yreka portal. At both localities, the mineralization was found to be richer in zinc than at the mine, possibly indicating that they are more distal to the source of mineralization. The main skarn unit dips to the southwest, towards the North Arm prospect where the company has located numerous gossans and a broad area of anomalous copper and molybdenum soil geochemistry. The showing may be closer to a porphyry source.

FANDORA (MINFILE 092F 041)

Doublestar Resources Limited has acquired the past-producing Fandora gold mine, near Tofino, and is assessing its potential as a small-scale, high-grade, underground operation. The deposit is a composite, sheeted quartz-carbonate vein system that contains a minor amount of coarse and fine-grained pyrite, arsenopyrite, chalcopyrite, sphalerite, galena and free gold. It is spatially and possibly genetically associated with an andesite dike in a northeasterly trending fracture in West Coast Complex rocks.

The deposit was developed by Privateer Mines Limited on four levels in the late 1940s. In 1950, it was described as having a "composite reserve" of 181 434 tonnes grading 12.74 g/t Au in ten ore shoots within two subparallel veins. It was later acquired by a consortium controlled by Moneta Porcupine Limited and produced 972 tonnes containing 45 660 grams of gold, 8367 grams of silver and small amounts of copper, lead and zinc between 1960 and 1964.

In 1999, Doublestar reopened one of the adits and mined a 1000 kilogram bulk sample for metallurgical work and acid-base accounting tests. Preliminary bottle roll data appear to indicate good recoveries for less than 100 mesh material. The company plans to rehabilitate the remaining underground workings and drill the deposit, both from surface and underground, to confirm the extent of the resource and trace the vein system down dip.

TAY (MINFILE 092F 212)

Dalmation Resources Limited has similar veins to those at Fandora on its Tay property, west of Port Alberni. Since the 1970s, it has drilled a number of gold-bearing, quartz-carbonate veins in splays that may be related to a major fault that trends along the axis of the Taylor River valley. In 1996, it flew an airborne geophysical survey and located numerous anomalies.

The company diamond drilled two targets in 1999. It drilled two holes for an aggregate depth of approximately 100 metres, looking for extensions to the Apex vein; however, the results were negative. It also drilled three holes, for an aggregate depth of 400 metres, into a road-side copper-bearing magnetite skarn showing. The occurrence is near an intrusive contact that is coincident with a resistivity anomaly on the south side of the Taylor River fault.

MACTUSH (MINFILE 092F 012)

SYMC Resources Limited is exploring for higher-grade veins and mineralized shear zones on Vancouver Island. In 1999, it explored a large land holding that includes the Mactush and neighbouring properties in the Port Alberni region. The company trenched copper mineralization in a shear zone at the former Bell (MINFILE 092F 383) prospect and deepened and resampled some of the trenches on the previously explored Fred and Dave gold-bearing quartz veins on the Mactush property. It also prospected along the shore of Alberni Inlet and located additional adits and dumps associated with the Dauntless deposit (MINFILE 092F

168). Elsewhere, it relocated some of the copper and silver-bearing quartz veins previously reported on the Holk (MINFILE 092F 155) property and some of the gold and copper-bearing quartz veins previously identified on the Devil's Den (MINFILE 092F 551) property.

Also in 1999, SYMC Resources extracted small (20 kilograms) samples from two of the high-grade, shear-hosted vein systems for preliminary metallurgical studies. According to the company, the MC (MINFILE 092F 103) sample assayed 16.24% Cu, 7.81 g/t Au and 274.9 g/t Ag and the Dauntless sample assayed 18.13% Cu, 0.24 g/t Au and 34.28 g/t Ag. The samples were processed individually and also as a composite. The flotation recoveries are encouraging. When ground to 96% less than 75 microns (200 mesh), the composite sample produced copper, gold and silver recoveries of 95% or better. Although none of the vein systems in the area currently have a defined mining reserve, or have been adequately drilled, the company plans to establish a central, modular mill, capable of handling material from the Fred and Dave veins at Mactush and also the MC and Dauntless deposits. It recently bought some of the processing equipment last used at the Northair mine, near Squamish.

VALENTINE MOUNTAIN (MINFILE 092B 108)

Beau Pre Explorations Limited began a diamond drilling program in the BN area on its Valentine Mountain property in December, 1998, and completed it in 1999. The holes were drilled to provide a composite section through a broad, 100 metres wide, alteration zone that is coincident with a discordant magnetic anomaly and a pronounced topographic linear.

After drilling a 306-metre hole in 1998, Beau Pre drilled two more holes for an aggregate depth of 400 metres in 1999. They intersected a 30-metre wide quartz and carbonate veinlet stockwork in altered amphibolite and biotite schist containing trace amounts of arsenopyrite and geochemically anomalous amounts of gold.

OTHER ACTIVITY

Two companies with small operating mills are currently processing limited tonnages (<500 tonnes) from existing stockpiles. On Vancouver Island, Newmex Minerals Inc. processed a small tonnage of gold-bearing vein quartz extracted from the Privateer mine (MINFILE 092L 008), near Zeballos, in 1998. On Texada Island, International Metals Research processed a few tonnes through the Bolivar mill. It has refurbished the plant and installed gravity and flotation circuits suitable for processing gold-bearing skarn ore from the Yew pit (MINFILE 092F 516). The company has a small amount of stockpiled ore to process and has permits to mine an additional 6500 tonnes.

Also in 1999, Doublestar Resources Limited reached agreement with Falconbridge Limited and acquired its interests in several properties on Vancouver Island; including: the Catface (MINFILE 092F 120) porphyry copper deposit (indicated resource of 188 000 000 tonnes grading 0.42% Cu and 0.08% Mo at a 0.30% Cu cut-off and 1.1:1 stripping ratio), near Tofino; the Chemainus volcanogenic massive sulphide property (MINFILE 092B 037) near Duncan and the past-producing Churchill (MINFILE 092L 031) and adjacent Hiller (MINFILE 092L 068 etc.) magnetite deposits near Zeballos. The company is currently evaluating data for these properties. In the spring of 2000, it plans to extend the geophysical coverage at Catface.

Doublestar Resources Limited has also been active elsewhere on Vancouver Island. In addition to its work at Fandora, it completed a small geophysical program on the Storey Creek property, which includes the Smith copper-zinc skarn deposit (MINFILE 092L 208), east of Nimpkish Lake. The company hopes to add to an indicated resource of 83 906 tonnes grading 64.4 g/t Ag, 1.69% Cu, 3.7% Pb, 12.5% Zn.

Near Campbell River, Better Resources Limited conducted a preliminary soil geochemical survey over the past-producing Blue Grouse (MINFILE 092F 358) polymetallic skarn occurrence, in an area largely covered by till.

Homegold Resources Limited has spent the past several years exploring for industrial minerals in southwestern British Columbia. In 1999, it completed a modest diamond drill program (9 holes with an aggregate length of 366 metres) exploring for industrial grade silica and kaolinite on its Apple Bay property, on Holberg Inlet, at the north end of Vancouver Island.

SOUTHERN COAST

DUCK LAKE

There has been very little exploration in the Lang Bay area, near Powell River, since Lang Bay Resources Limited explored a bright white, kaolin clay deposit in the early-1990s. However, in 1999, Homegold Resources Limited completed four short, packsack diamond-drill holes for an aggregate depth of approximately 300 metres near Hammil Lake, at the northern end of the Lang Bay sedimentary basin. The holes were logged to determine the thickness of an overlying till blanket and the core was studied to establish the composition and quality of the clay. The drill logs show considerable variation in the amount of cover on the property and the company later undertook seismic and other geophysical surveys to get a better appreciation of its distribution.

STAN (MINFILE 092JW 006)

Lorex Minerals Inc. explored the Stan property, near Whistler. The property is underlain by plutonic rocks and by volcanic and sedimentary rocks of the Gambier Group Callaghan roof pendant. It is adjacent to the Brandywine property, which was extensively explored in the mid-1990s.

The pendant rocks contain shear and skarn-hosted disseminations and bands of sulphides that show local enrichment in gold. In 1999, Lorex trenched and diamond drilled (five holes for an aggregate depth of 500 metres) several geochemical and geophysical anomalies and extended the grid for a further 10 line kilometres. The results were not encouraging, the best drill intercept reported was 3.91 g/t Au over 1.5 metres.

VULCAN (MINFILE 092JW 039)

Elsewhere, TDB Forestry Services Limited trenched the Salal Creek pumice deposit, northeast of Mount Meager, to determine the average thickness of the pumice bed and its fragment-size distribution. The deposit varies from 4 to 10 metres in thickness and is mostly coarse grained. The site is east of the Lillooet River, a few kilometres downstream from Great Pacific Pumice's existing quarry.

OTHER ACTIVITY

Although there was no exploration at the past-producing Ladner Creek (Carolin mine) property in 1999, Hillsbar Gold Inc. conducted a modest prospecting and geochemical sampling program looking for gold mineralization south of Siwash Creek (092HNW038). It explored a narrow zone of silicification and mineralization on a ridge close to the trace of the Hozameen fault.

Platinate Minerals and Industries Limited holds a large block of placer tenures on Tuwasis Creek and along the Lillooet River, north of Harrison Lake. It recently acquired permits to test mine part of the Tuwasis Creek placer but has yet to do so. Since the discovery of a new road-side gold showing, in 1998, it has focused on the lode potential of the area. The company has staked a large block of mineral claims over its placer tenures and adjacent areas along the Lillooet River.

In 1999, there were at least two discoveries made by prospectors with the Ministry's Prospectors Assistance Program. Arnd Burgert, who discovered a small lens of possibly volcanogenic massive sulphide in a Gambier Group pendant, near Powell River, while working on the program in 1998, made another discovery in 1999. He located a second, 0.7 metre-wide, lens enriched in gold, silver, copper, lead and zinc in the same general area.

David Haughton located a road-side boulder of hornblendite with net-textured, magmatic sulphide similar to that found at the past-producing Giant Mascot mine, while exploring around Talc Creek, east of Harrison Lake. Although the boulder is only weakly enriched in nickel and copper, it indicates the right geological environment for magmatic nickel-copper deposits.

As part of its agreement with Falconbridge Limited, Doublestar Resources Limited will acquire Falconbridge's interests in the Baldwin and McVicar crown grants in the Britannia mine area, near Squamish. The property is reported to contain a resource of approximately 120 000 tonnes grading 2% Cu (MINFILE 092GNW006).

There was also some modest exploration for industrial minerals in the Lower Mainland. Quality Industrial Mineral and Supply Limited resumed exploration for feldspar for use in the ceramic industry. It drilled approximately 20 short holes, for an aggregate depth of 300 metres, near the top of Sumas Mountain (MINFILE 092GSE037).

ACKNOWLEDGMENTS

The Mineral Development Office provides information and client-oriented services to researchers, prospectors and others involved in exploration and mine development. In 1999, it also handled the Regional Geology function for the Southwestern Region.

The author gratefully acknowledges the contribution numerous prospectors, public and private sector geologists and other professionals have made to this report. Without their support, exploration reviews such as this would not be possible.

SOUTH-CENTRAL REGION

by Michael S. Cathro, P.Geo.
Regional Geologist, Kamloops

SUMMARY

- Mining operations were suspended at **Highland Valley Copper** from mid-May to early September, due to low copper prices and ongoing labour negotiations. The **Blackdome** gold-silver mine, owned by Claimstaker Resources Ltd. and Jipangu Inc., was closed in May due to low gold prices.
- Development of the 250 000 tonne per year **Ashcroft** basalt quarry (Photo 1) was begun by I.G. Machine and Fibers Ltd. Site preparation and definition drilling were completed in late 1999. Mining and plant construction should begin in mid-2000.
- Exploration was slow in 1999 with only seven major projects (vs. nine in 1998), $2.5 million in spending (vs. $4.0 million), and 12 000 metres of drilling (vs. 14 000 metres).
- Claim staking was relatively strong, with over 5700 new mineral claim units recorded, however, more than 10 000 units lapsed. On the positive side, good ground and significant deposits continue to come open for re-staking.
- Exploration interest in intrusion-related gold-bismuth-tungsten deposits was quite strong, with numerous prospectors active in the Adams-Shuswap area. In addition, Teck Corp. drilled the **Cam-Gloria** gold prospect, an intrusion-hosted quartz vein prospect near Adams Lake, while Cassidy Gold Corp. drilled a gold-bismuth-copper prospect in high-grade metamorphic rocks on the **Goldstrike** (Bizar) property to the north.
- Reconnaissance work was conducted for gold, copper and zinc by several major and junior companies.

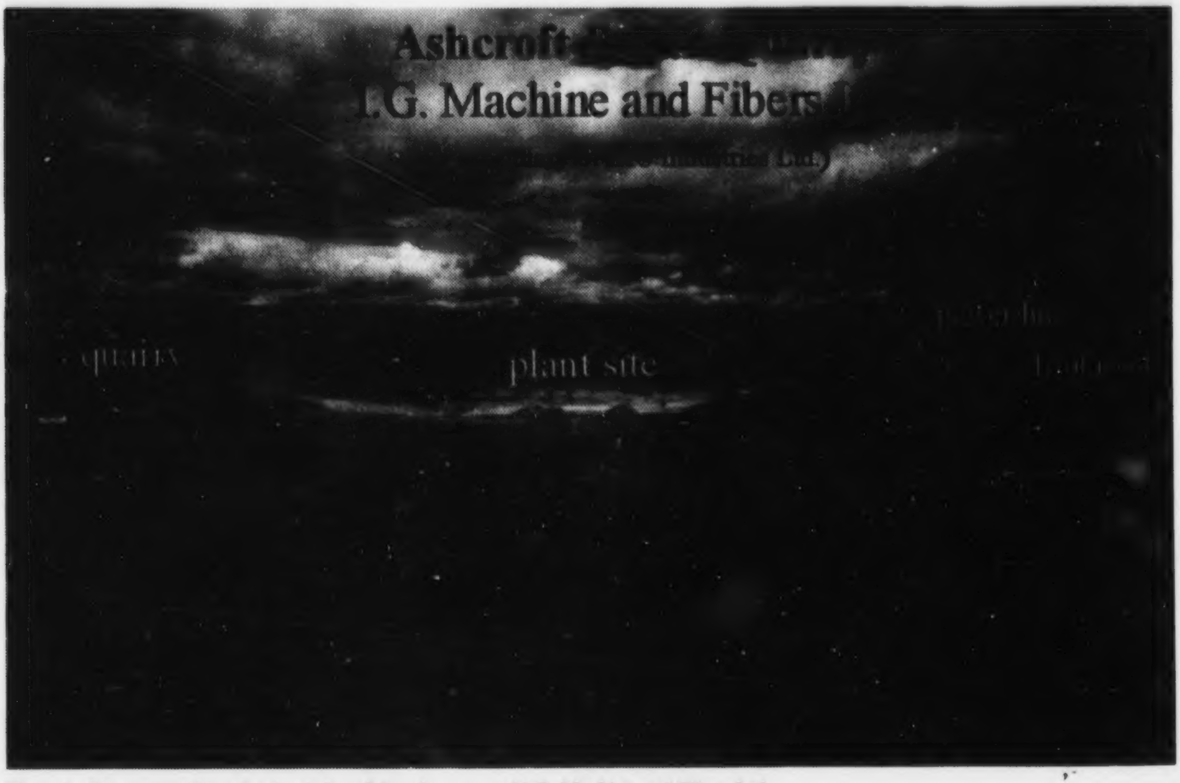

Photo 1. Site preparations for the Ashcroft basalt quarry of I.G. Machine and Fibers Ltd.

EXPLORATION TRENDS

Exploration indicators for the South-Central region registered declines in 1999 in terms of exploration and development spending (Figure 1), metres of drilling (Figure 2), and number of major projects (Figure 3). Exploration spending for 1999 is estimated at $2.5 million while drilling activity declined to about 12 000 metres. There were seven major exploration projects (Table 1 and Figure 5).

A positive sign was that several major and junior companies were quietly conducting reconnaissance prospecting programs in the area, mainly for copper, gold and zinc.

The main targets explored for were epithermal and mesothermal gold-silver veins, copper-gold-silver-molybdenum porphyries and industrial minerals. Junior companies were responsible for the majority of spending.

A total of 5713 claim units were staked in the region between January and November, 1999, a relatively high level in comparison to the previous eight years (Figure 4). Unfortunately, claim forfeitures exceeded new claims staked by over 4300 claim units, resulting in a net loss of an estimated 85 000 hectares of good-standing mineral tenure in the region.

The large number of claim forfeitures is attributed to the low level of exploration work, combined with the lapsing of claims which had ten-year assessment credits applied during the last exploration boom in the late 1980s. Numerous other claims are slated to lapse over the next few years and some attractive deposits and prospective ground will come open for new staking.

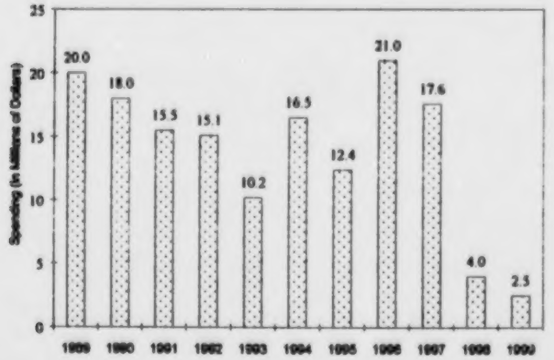

Figure 1. Annual exploration spending, in millions of dollars, South-Central Region.

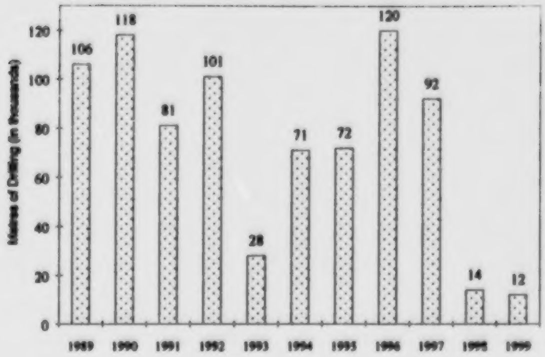

Figure 2. Annual exploration and development drilling, in thousands of metres, South-Central Region.

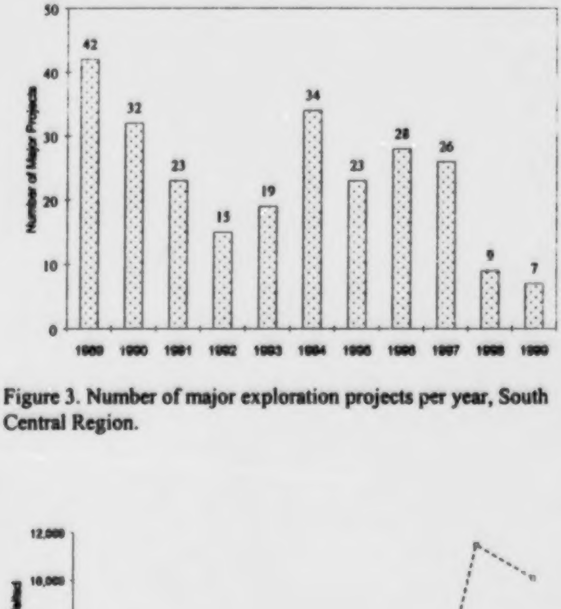

Figure 3. Number of major exploration projects per year, South Central Region.

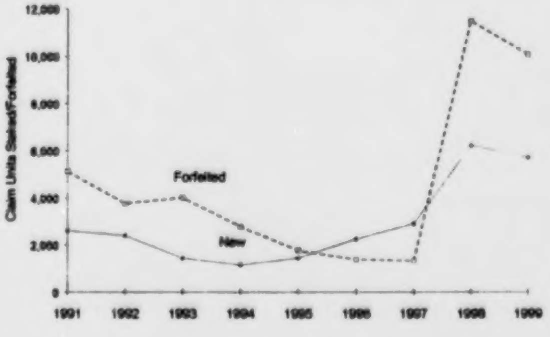

Figure 4. Number of new claims units staked vs. claim units forfeited per year, South-Central Region. Source: Mineral Titles Branch.

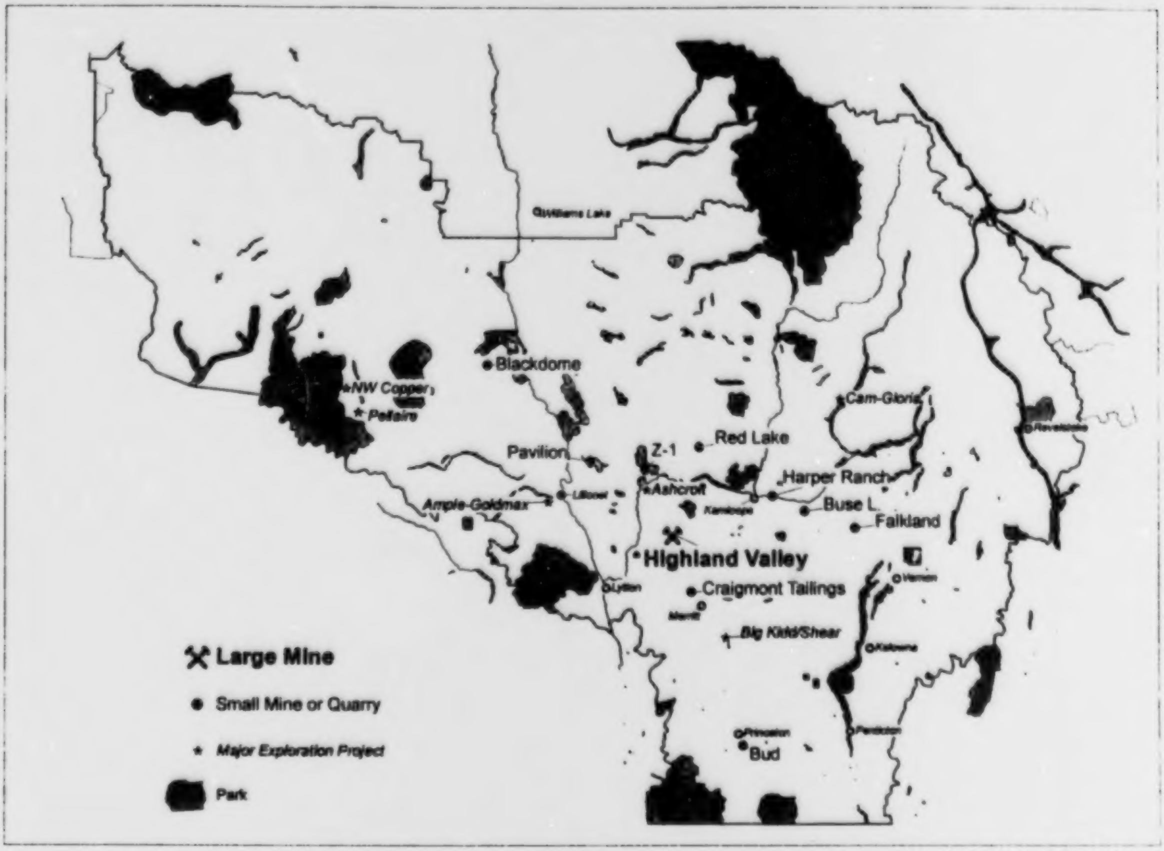
Williams Lake
Blackdome
NW Copper
Pellaire
Pavilion
Z-1
Red Lake
Cam-Gloria
Revelstoke
Harper Ranch
Ashcroft
Lillooet
Ample-Goldmax
Kamloops
Buse L.
Falkland
Highland Valley
Vernon
Lytton
Craigmont Tailings
Merritt
Big Kidd/Shear
Kelowna
Penticton
Princeton
Bud
Large Mine
Small Mine or Quarry
Major Exploration Project
Park

Figure 5. Operating mines and major exploration projects, South-Central Region. 1999.

TABLE 1 MAJOR EXPLORATION PROJECTS, SOUTH-CENTRAL REGION, 1999

Property	Operator	MINFILE #	NTS	Commodities	Deposit Type	Work Done
Ample Goldmax	Gold-Ore Resources Ltd.	092JNE069, 84, 94	92J/09E	Au, Ag	Mesothermal vein	9 ddh, 907 m; drill access trail
Ashcroft Quarry	I.G. Machine and Fibers Ltd.	092INW104	92I/11W	Basalt	Industrial mineral	46 ddh, 1312 m; 9 geotech ddh, 207 m; stripping; road
Big Kidd	Christopher James Gold Corp.	092HNE074	92H/15E	Au, Cu	Porphyry, breccia	4 ddh, 1060 m
Blackdome Mine	Claimstaker Resources Ltd.	092O 053	92O/08W	Au, Ag	Epithermal vein	7 u/g ddh, 1061 m
Cam-Gloria	Teck Corp.	082M 266	82M/04E	Au, Ag	Intrusion-hosted vein	7 ddh, 836 m; trenching; geophys; geochem
Northwest Copper	International Jaguar Equities Inc.	092O 043	92O/04E	Cu, Ag	Stockwork, vein	3 ddh, 667 m; geol
Pellaire	International Jaguar Equities Inc.	092O 045	92O/04E	Au, Ag	Vein	Bulk sample, approx 1400 tonnes

MINES

The porphyry copper-molybdenum-gold-silver **Highland Valley Copper** (HVC) mine (Photo 2), a partnership of Cominco Ltd. (50%), Rio Algom Ltd. (33.6%), Teck Corp. (13.9%) and Highmont Mining Co. (2.5%), was shut down from May 15 until early September due to low copper prices and labour negotiations. In August, the unionized employees ratified a new five-year, risk-sharing labour agreement that ties wages to the price of copper. HVC also negotiated a "Power for Jobs" agreement with BC Hydro that ties power rates to the price of copper.

Photo 2. Valley pit at Highland Valley Copper.

For the 1999 fiscal year, Cominco Ltd. reported a $5 million profit (net of hedging gains) on revenue of $127 million for its 50% interest in HVC. Total production for 1999 was 109 600 tonnes of copper metal, 1400 tonnes of molybdenum metal, 1 329 600 ounces of silver and 9400 ounces of gold contained in concentrate. (Cominco Ltd. 1999 Annual Report).

The **Blackdome** gold-silver mine, a high-grade underground producer, shut down due to low gold prices in mid-May and is now on care and maintenance status. Mineralization at Blackdome consists of epithermal quartz-carbonate veins hosted by Tertiary volcanic rocks. Located near Clinton, the mine operated between 1986 and 1991, and is now owned by Claimstaker Resources Ltd. (50%; operator) and Jipangu Inc. (50%). Gold and silver sales were reported by Claimstaker to be approximately $1.507 million during the period of operation between October, 1998 and May, 1999 (Claimstaker Quarterly Reports, 1998 and 1999). Reserves at start-up were reported as 128 627 tonnes grading 14.0 g/t gold in the proven and probable categories. Prior to the recent mining, the fully diluted resource, including drill-indicated resources, was 237 881 tonnes grading 13.1 g/t gold and 37.1 g/t silver (Claimstaker Resources Ltd., News Release, May 27, 1998). The partners conducted an underground drilling program in spring 1999 to test the No. 11 vein.

Numerous small mines and quarries operated throughout the region during the year (Figure 5). Western Industrial Clay Products Ltd. operates the **Red Lake** quarry which supplies diatomaceous earth to a plant in Kamloops. The company produces kitty litter, barn deodorizer and industrial absorbents. Bentonite from the **Bud** quarry at Princeton is used as a clumping agent in some of the company's products. At **Pavilion**, Continental Lime Ltd. operates a limestone quarry and lime kiln. M Seven Industries Ltd. produces magnetite on an intermittent basis by reprocessing tailings from the old **Craigmont** copper mine near Merritt. The magnetite is used in coal-washing plants throughout western Canada.

Highwood Resources Ltd. mines limited quantities of zeolite for industrial and agricultural uses from its **Z1** quarry near Cache Creek. During 1999, control of Highwood was bought by Dynatec Corp. In early 2000, Highwood closed its Limeco plant at Rocky Mountain House, which had been processing Z1 zeolite. The material will now be shipped to its Lethbridge plant.

C_2C Mining Corp. mines zeolite-bearing shale from the **Z2** quarry at Cache Creek, and processes the rock into various products at its plant in Ashcroft (Photo 3). Deodorizers, feed binders, cat litters and industrial absorbents are sold in bulk and bagged form under the trade names *Muckers Mate*, *Cage*, *Cage T408* and *Zippity Doo*. The company is also developing a commercial process for lightweight zeolite concrete.

The **Kingfisher** marble quarry, located northeast of Vernon, was bought by Andrew Hokhold who plans to re-open it. Site clean-up took place in 1999. In previous years the quarry produced attractive white and grey-banded marble blocks which were processed into cut and split ashler.

The Kamloops cement plant and **Harper Ranch** limestone quarry of Lafarge Canada Inc. were temporarily closed in November, 1999 and will now operate at half capacity unless markets improve. The production cutback is due to a slowdown in the construction industry and the opening of a larger, more efficient Lafarge plant in Richmond. At the end of 1999 the workforce at the cement plant was reduced to about 26 people, from 42, through early retirement of older employees. In addition, nine people are employed by a contractor, on an intermittent basis, doing quarry work at the Harper Ranch, **Falkland** (gypsum) and **Buse Lake** (silica-alumina rock) quarries.

The large, low-grade **Similco** porphyry copper-gold mine, owned by Imperial Metals Corp., closed in September, 1996 and remains on care and maintenance pending an improvement in metal prices. A resource of 142 million tonnes grading 0.397% copper has been outlined in the area of Pits 2 and 3 on the Copper Mountain side of the property (Imperial Metals Corp., Annual Report, 1997).

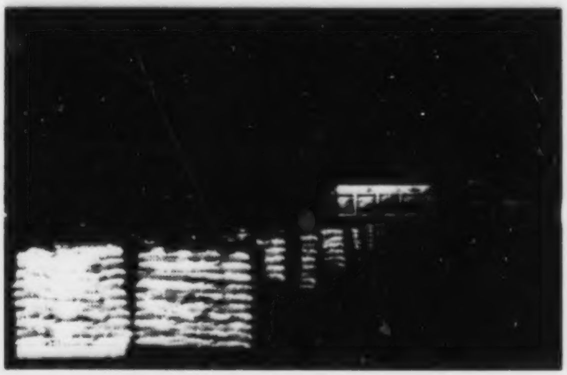

Photo 3. Zeolite processing plant of C_2C Mining Corp., at Ashcroft.

DEVELOPMENT PROJECTS

At **Ashcroft**, permits were issued for a 250 000 tonne per year basalt quarry and roofing granule plant to be developed by I.G. Machine and Fiber Ltd., a subsidiary of IKO Industries Ltd. The company conducted definition and geotechnical drilling, stripped overburden from the quarry and plant site, and cleared the powerline right-of-way (Photo 1). In addition, year-round access to the minesite was improved by upgrading the Barnes Lake road on a shared-cost basis with the Ministry of Transportation and Highways.

Nicola Group basalt will be mined, crushed, sized and coloured at the Ashcroft site, and then shipped to existing IKO Industries roofing shingle plants in Calgary and Sumas, Washington. Undersized material would be sold for winter road sand and other local uses. The company estimates the operation will employ 40- to 60 people and require a capital investment of about $30 million.

The **Prosperity** copper-gold project of Taseko Mines Ltd. is located at Fish Lake, southwest of Williams Lake. A large open-pit mine is proposed and in 1999, Taseko and its consultants continued work on feasibility studies and environmental permitting. Reserves were recalculated by Independent Mining Consultants, Inc. in early 1998, based on extensive angle re-drilling of the deposit in 1996-97, and total 633 million tonnes grading 0.253% copper and 0.466 g/t gold. Recent feasibility work suggests a 70 000 tonne per day milling rate and an operating life of 19 years is the optimum plan for the project (Taseko Mines Ltd., News Release, January 18, 2000). The project is being reviewed under the B.C. and Canadian Environmental Assessment Acts. In 1998, the company signed a Cooperative Resource Development Protocol with the provincial government under the "Power for Jobs" initiative, which will allow for the negotiation of favourable power rates for the mine.

Market studies, coal quality testing and sampling, and environmental monitoring were completed at the **Tulameen Coal** project, located 20 kilometres northwest of Princeton. Pacific West Coal Ltd. obtained approval for an initial start-up production of 100 000 tonnes per year of thermal coal from its licenses located directly north of the former producing, underground and open-pit Blakeburn Collieries (1912-1954). The Main coal seam is between 18 and 34 metres thick with interbedded shale and bentonitic ash partings. It dips easterly at 25° to 45°. Following the 1998 in-fill core-drilling program along a 1.5-kilometre strike length, the estimated proven, recoverable raw coal reserves are 11 230 000 tonnes at 3:1 stripping ratio. Additional reserves are indicated along strike and down dip from the current mine development plan. It is high-volatile bituminous B and C rank coal and can be cleaned to produce a product with an acceptable content of ash, moisture, sulphur and energy. Potential markets are industrial users in the Lower Mainland, US Northwest and overseas. The project could initially employ up to 30 people, including trucking jobs.

There was no activity on the **Getty North** deposit of Getty Copper Corp. The deposit is estimated to contain a resource of 72.1 million tonnes grading 0.31% copper, which includes a higher grade oxide resource of 10.0 million tonnes grading 0.40% copper (Getty Copper Annual Report, 1997).

The proposed **Bralorne** gold mine project remains on care and maintenance status due to the low price of gold.

A change in management and a $742 000 financing bode well for the **Lumby** graphite-sericite project of The Quinto Mining Corp. The project has a permit in place for a 75 000 tonne per year mine and it is hoped that limited production will begin in 2000.

The Kettle Valley Stone Company, a subsidiary of L. & D. Petch Contracting Ltd., has been successful in developing markets in western North America for its attractive flagstone, ashler, and landscape-rock products. Southeast of Kelowna, the company mines a buff-tan dacitic ash from its **Nipple Mountain** quarry, and "Rainbow Granite" (Okanagan Gneiss) from the **Canyon** quarry. Columnar basalt from the Big White area is marketed for landscape rock and the company is evaluating other properties to expand their product line.

EXPLORATION PROJECTS

Gold-Ore Resources Ltd. drilled nine holes on the **Ample/Goldmax** property located near Lillooet, to follow-up on several good holes drilled by Homestake Canada Inc. in 1996-97. Mesothermal gold mineralization is hosted by gently dipping quartz veins which cut mainly argillites of the Cayoosh assemblage, just below the thrust faulted contact with greenstone and chert of the Bridge River Group above (Photo 4). Moderate grades were encountered over variable widths in the 1999 drilling, and combined with previous drilling results, "indicate a moderate to high-grade (7 to 31.5 g/t) northeast-plunging gold shoot 50 to 100 m wide, 1.5 to 8 m thick and at least 200 m long…which is open down-plunge to the northeast" (Gold-Ore Resources Ltd., News Release, August 25, 1999).

Photo 4. Ample/Goldmax property of Gold-Ore Resources Ltd.

Teck Corporation drilled seven holes and conducted trenching, mapping and geophysical work on the **Cam-Gloria** gold prospect located west of Adams Lake. The property was optioned in early 1999 from Camille Berubé who, in 1997, discovered gold values in a large quartz vein hosted by granitic rock of the mid-Cretaceous Baldy batholith. The Teck work defined a zone of quartz veining and sericitic alteration up to 40 metres wide and 700 metres in strike length. Individual quartz veins are up to 7.3 metres in true width (Randy Farmer, personal communication, November 1999). No assays have been released. The geology of this prospect is more fully described in papers by Logan (2000) and Cathro and Lefebure (2000) and an Open File geological map of the area was published by Logan and Mann (2000).

At the **Pellaire** project located southwest of Williams Lake, International Jaguar Equities Ltd. undertook surface trenching on the #3, 4 and 5 quartz-telluride veins to collect a bulk sample (Photo 5). Approximately 1400 tonnes was mined and trucked to the camp, and this will be processed on site by gravity means or trucked to a smelter in mid-2000 (Andy Smith, Personal Communication, November, 1999).

Photo 5. Trenching on #4 and #5 veins, Pellaire project, International Jaguar Equities Ltd.

Late in the season, Jaguar drilled three short holes to test mineralization at the **Northwest Copper** (Charlie Northwest) area, north of the Pellaire property. Copper-silver mineralization is reported to consist of bornite, native copper, malachite and chalcopyrite, associated with quartz, carbonate, epidote and sericite in shears and veins and disseminated in volcanic rocks and porphyry dikes. The company indicates that seven showings have been discovered over an area of 4.5 square kilometres, however, four holes drilled in 1999 had somewhat disappointing results (e.g. 0.18 % Cu over 4.4 m). Induced polarization surveys are planned prior to the next phase of drilling (International Jaguar Equities Inc., Press Release, September 30, 1999).

Christopher James Gold Corp. was active on several projects in 1999. At the **Big Kidd** alkalic porphyry gold-copper project near Aspen Grove, the company drilled four holes totaling 1080 metres in the North Breccia target. The 1999 holes were 50-metre step-outs from previous good holes (e.g. 3.09 g/t Au and 0.11% Cu over 19.46 m in hole 97-5). The best hole, NBZ99-02 cut 70.28 metres grading 0.62 g/t Au and 0.21% Cu. The other holes intersected similar broad widths of mineralization but with lower grades. Near Walhachin, Christopher

James Gold Corp. drilled three holes on the **Brassie** property, to test zinc skarn/replacement mineralization in carbonate beds of the Nicola Group, adjacent to the northeast margin of the Guichon Creek batholith. Two of the holes encountered wide zones of low-grade mineralization (0.82% Zn and 4.74 g/t Ag over 29.45 m, and 0.83% Zn over 12.85 m).

GRASSROOTS WORK

Several interesting new discoveries were reported by individuals in 1999. Near Lillooet, Gary Polischuk staked the **Aumax** claims to cover two areas of mineralization. The most interesting of these, the "97 Zone", consists of 0.5-metre boulders of quartz with minor tetrahedrite which are found in recent roadcuts and logged areas. Assays of up to 2820 g/t (82 oz/ton) Ag and 14.7 g/t Au were returned from grab samples collected by this author. Polischuk's work was supported by a Prospectors Assistance grant and he optioned the property to Gold-Ore Resources Ltd. in September, 1999. Unfortunately, Gold-Ore dropped the property later in the fall after trenching determined that the mineralization was transported.

While working under a Prospectors Assistance grant, geologist Warner Gruenwald staked the 58 unit **GQ** property northeast of Anstey Arm on Shuswap Lake. The claims cover unusual gold-copper-bismuth-tungsten mineralization which is associated with pegmatite dikes within amphibolite-grade gneisses of the Shuswap Metamorphic Complex (Cathro and Lefebure, 2000). At least five occurrences were discovered in bedrock, and silt samples show there are other anomalous watersheds on the claims that are worthy of detailed prospecting.

Another Prospectors Assistance grantee, Camille Berubé, worked in the East Barriere Lake area to the northwest of Teck's Cam-Gloria gold prospect. He and partners Len and Dave Piggin staked the large **Lucky Bear** claim group, and discovered several new occurrences of tungsten mineralization with minor gold and bismuth values. Tungsten occurs in skarn, pegmatite, sheeted veins and solitary veins (Cathro and Lefebure, 2000).

OUTLOOK FOR 2000

It is hoped that there will be rebound in exploration activity in 2000. There are already indications of small to moderate drilling projects on the Big Kidd, Brassie, and Blackdome projects described above. Drilling is also planned for early 2000 on the **Ledge** (TNR Resources Ltd./Ivory Oil & Minerals Ltd.) and **Ophir Copper** (GWR Resources Inc.) properties.

In addition, there was a change in ownership for several significant properties in 1999, and exploration projects are being planned for 2000. The mine leases covering Teck Corporation's **Afton and Pothook** pits were allowed to lapse in 1999, and were re-staked and optioned to DRC Resources Corp. DRC plans to drill beneath the Afton pit to test and expand high-grade alkalic porphyry mineralization with an estimated underground reserve of 5.9 million tonnes grading 1.55% Cu, 1.6 g/t Au and 7 g/t Ag (Afton Mines Ltd., Annual Report, 1980). North of Clearwater, the **CK** stratiform zinc-lead-silver deposit, with a resource of 1.627 million tonnes grading 8.6% Zn and 1.4% Pb, was optioned by BWI Resources Ltd. BWI plans to drill the deposit in 2000. Finally, Doublestar Resources Ltd. acquired a 58.91% interest in the **Ruddock Creek** stratiform zinc-lead deposit from Falconbridge Ltd. The remaining interest in the property is owned by Cominco Ltd. and a mineral resource of 1.5 million tonnes grading 8.4% Zn and 1.6% Pb is reported.

ACKNOWLEDGEMENTS

I am grateful to the many prospectors, geologists and project managers for sharing their information and ideas with me, and for their hospitality in the field. As usual, Bruce Madu of the Ministry's Kamloops office provided timely and cheerful help with computer graphics.

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KOOTENAY REGION

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SUMMARY

Exploration expenditures in the Kootenay region in 1999, including those at operating mines and quarries, are estimated to have totalled $7.0 million, a reduction of approximately 37% from the corresponding estimate for 1998 (Figure 1). Of that amount, about $1.6 million was spent on exploration drilling for coal at or in the vicinity of the producing coal mines in the Elk Valley, with the remaining $5.4 million spent on exploration for metals and industrial minerals throughout the region.

There were 171 projects (mineral, coal, and placer) known to have been active in the region during the year, only a slight reduction from the corresponding tally for 1998 (Figure 2). Similarly, the total amount of exploration drilling in 1999 is estimated at 60 930 metres, actually a very slight increase over the 1998 estimate (Figure 3). Of that total, 36 243 metres, or approximately 60%, was reverse-circulation drilling to test coal resources in the Elk Valley.

These data indicate that the overall level of exploration activity, as measured by the number of discrete projects carried out in the field, remained fairly constant through 1998 and 1999. However, most of those projects involved minimal expenditures and the total amount of money actually spent on exploration in the region continued to decrease significantly. Many of the projects managed to achieve only a portion of their planned work due to the inability of the operators to raise or commit sufficient funding. The total amount of drilling was sustained by minesite exploration for coal and should not be interpreted as indicating a healthy level of drilling for new metal or industrial mineral resources. The good news was that several of the highlight projects, although restrained by lower than expected budgets in 1999, have been able to refine their targets for drilling and other advanced work, and optimism remains high for increased activity and expenditures in 2000.

As is illustrated by the distribution of major projects (Figure 4), exploration for commodities other than coal was heavily focused in the eastern part of the region where the principal target is Sullivan-style, sedimentary

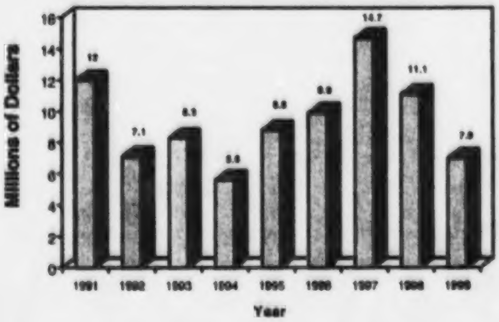


Figure 1. Exploration expenditures, Kootenay Region.

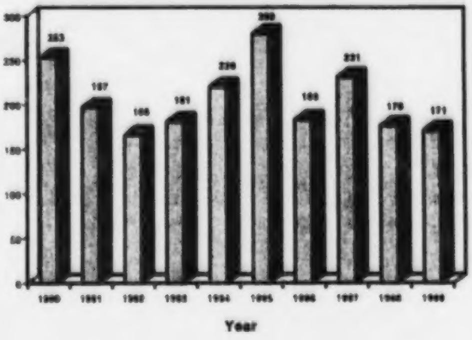


Figure 2. Exploration projects, Kootenay Region.

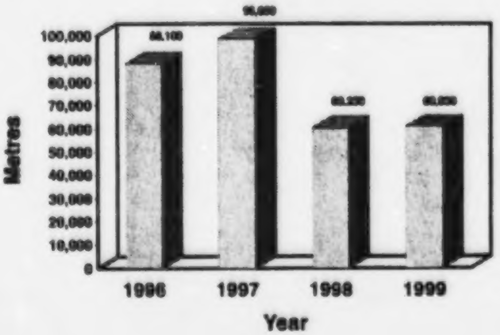


Figure 3. Total drilling, Kootenay Region.

exhalative (sedex), zinc-lead-silver deposits in the Purcell (Belt) Supergroup. Approximately $2 million is estimated to have been spent in 1999 on the search for a successor to the Sullivan orebody. In that search, there were two main concentrations of activity. In the Findlay and Doctor creeks area southwest of Canal Flats, three major companies, Kennecott Canada Exploration Inc., Rio Algom Exploration Inc. and Billiton Exploration Canada Inc., were all active on adjoining properties optioned from Eagle Plains Resources Ltd. Further south, in the St. Mary and Moyie rivers area, Chapleau Resources Ltd. and Black Bull Resources Inc. staged modest preliminary drilling programs on four properties, all with encouraging results. No significant new discoveries have been reported from any of the Purcell projects in 1999, but most have identified promising new anomalies or geological indications and an increase in drilling activity is anticipated for 2000.

In the western part of the region, exploration was limited mainly to prospecting and some grassroots exploration for silver and base metals or for intrusion-hosted gold. There were three modest drilling programs completed on properties in the Kootenay and Slocan lakes area and another targeting graphite west of Slocan, but there were no large-budget projects mounted west of Kootenay Lake. Nevertheless, there is still strong interest in, and major potential for, silver, zinc and gold occurrences in the Kootenay Arc, the Slocan camp and the Greenwood camp. Several junior companies remain committed to these areas and have optioned additional properties from local prospectors in 1999, increasing the probability of more activity in 2000. A significant and sustained rise in the price of gold would result in a dramatic revival of activity in the West Kootenay and Boundary regions.

There was a noticeable increase in the level of exploration for industrial minerals in 1999, particularly gypsum and barite. The Parson barite mine south of Golden, operated by Highwood Resources Ltd., closed during the year due to depletion of its reserves. However, approximately 16 kilometres southeast of the Parson mine, on Jubilee Mountain, WWC Consulting Ltd. carried out an aggressive program of drilling and underground bulk sampling of a series of barite veins optioned from a local prospector. In the Canal Flats area, the two local producers of gypsum, Westroc Inc. and Georgia Pacific Canada Inc., both completed drill tests of potential new reserves. Other industrial minerals, including magnesite, graphite, dimension stone and gemstones, also received attention from prospectors and some companies during 1999.

EXPLORATION HIGHLIGHTS

Table 1 gives details of the major metal, industrial mineral and coal projects in the region in 1999. The projects listed are those which involved significant expenditures on exploration drilling, bulk sampling or underground exploration work. The locations of those major projects, plus some smaller ones believed to have regional significance, are shown on a regional map, Figure 4. Only one project, Bull River, reported an expenditure greater than $1 million.

METALS

PURCELL ANTICLINORIUM

As noted in the summary above, 1999 saw a major concentration of the regional exploration for metals in rocks of the Middle Proterozoic Aldridge Formation of the Purcell (Belt) Supergroup which occur mainly in the core of a north-plunging anticlinorium east of Kootenay Lake. The main target in those rocks is Sullivan-style sedimentary exhalative (sedex) zinc-lead-silver mineralization. An estimated $2 million was spent this year searching for a successor to the Sullivan mine which is expected to deplete its reserves and close permanently in late 2001.

In the Findlay block of Aldridge Formation rocks, located southwest of Canal Flats and between Findlay and Skookumchuck creeks, Eagle Plains Resources Ltd. has optioned its extensive claim holdings to three major companies in three contiguous properties. The most northerly property, North Findlay, is subject to a joint venture agreement between Eagle Plains and Billiton Exploration Canada Ltd. In 1999, the joint venture, with Eagle Plains as operator, spent $400 000 on a program involving comprehensive mapping, soil geochemistry, and 1617 metres of diamond drilling in six holes. Kennecott Canada Exploration Inc., which had explored the property under option in 1998, had intersected a 105.2 metre interval of thin-bedded siliciclastic rocks, believed to be either Upper Aldridge Formation or lowermost Creston Formation, which were strongly anomalous in silver and lead throughout and contained 46 narrow, stratabound sulphide horizons. Soil sampling in 1999 outlined a continuous silver-lead-arsenic anomaly in tourmalinized rocks over a distance of 6 kilometres, conformable to stratigraphy and including the site of the Kennecott hole. Drilling by the joint venture tested the anomaly with six holes roughly spaced at1-kilometre intervals along its trace. Three of the holes intersected thick sections of metal-rich stratigraphy similar to that in the 1998 hole. The richest interval was in the first hole and returned 2.8 ppm Ag, 1730 ppm As, 2315 ppm Pb and 124 ppm Zn over 131.6 metres. Further drilling is planned for 2000.

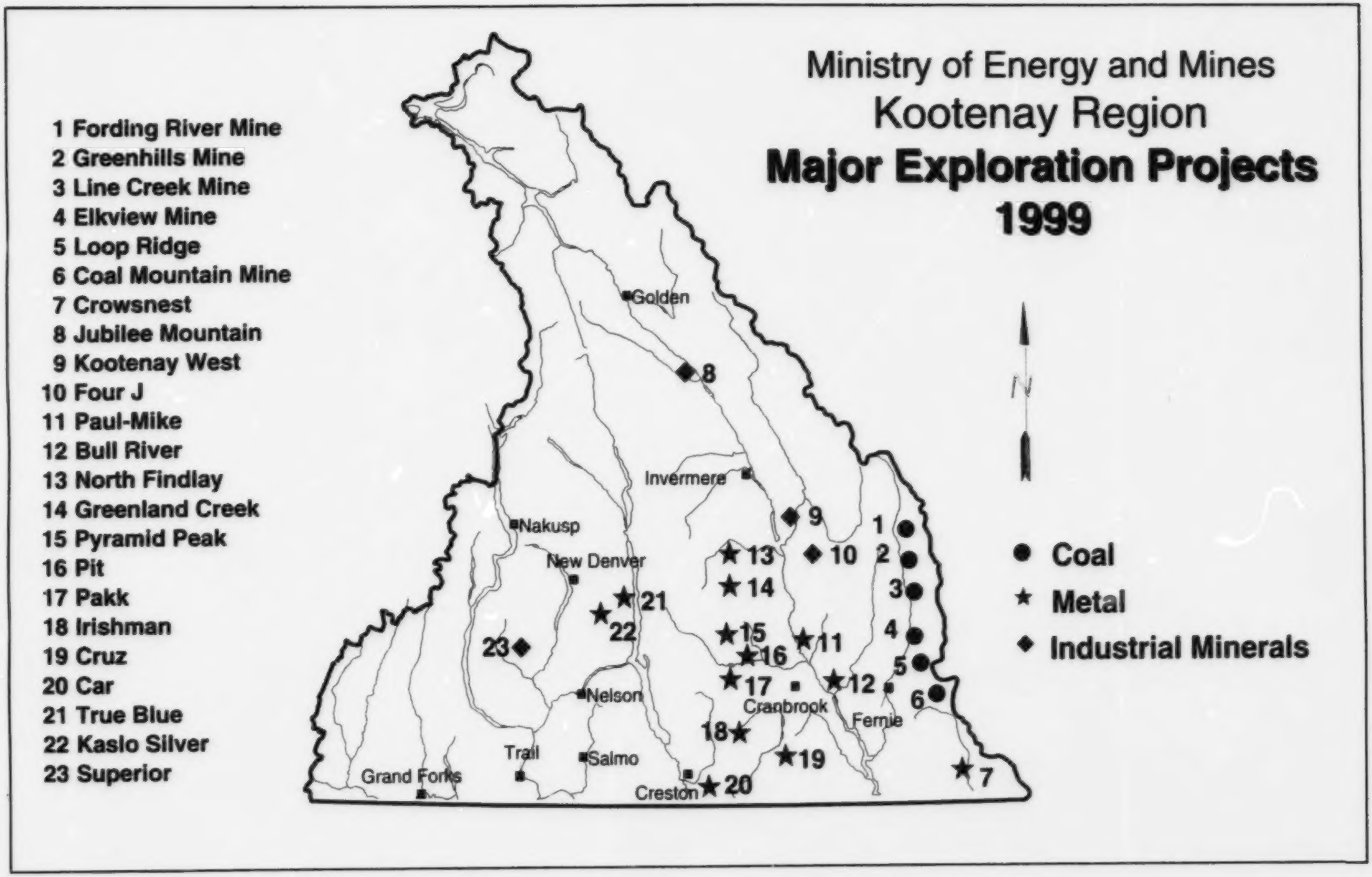
TABLE 1. MAJOR PROJECTS, KOOTENAY REGION, 1999

Property (Operator)	Minfile Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Bull River (R. H. Stanfield Group)	082GNW002	Fort Steele	82G/11W	Cu, Ag, Au	Mesothermal veins	u/g drifting; u/g and surface drilling
Car (Chapleau Resources Ltd.)	N/A	Fort Steele, Nelson	82F/1W	Zn, Pb, Ag	Sedex	6 ddh, 2309 m
Coal Mountain Mine (Fording Coal Ltd.)	082GSE052	Fort Steele	082G/7E, 10E	Coal	Coal	90 rdh, 10463 m
Crowsnest (Eastfield Res. Ltd., Internat. Curator Res. Ltd.)	082GSE070	Fort Steele	82G/2E	Au	Alkalic intrusion-hosted	10 ddh, 1096 m; geochem.; geophys.
Cruz (Chapleau Resources Ltd.)	N/A	Fort Steele	82G/4W	Zn, Pb, Ag	Sedex	~ 1525 m diamond drilling
Elkview Mine (Elkview Coal Corp.)	082GNE015	Fort Steele	82G/10W, 15W	Coal	Coal	66 rdh, 7000 m
Four J (Georgia Pacific Canada Inc.)	082JSW004, 009, 017	Fort Steele	82J/4E	Gypsum	Evaporite	56 rdh, 2284 m
Fording River Mine (Fording Coal Ltd.)	082JSE009, 010, 012	Fort Steele	82J/2W	Coal	Coal	8 rdh, 2000 m
Greenhills Mine (Fording Coal Ltd.)	082JSE007, 001, 005	Fort Steele	82J/2W	Coal	Coal	34 rdh, 3032 m
Greenland Creek (Kennecott Canada Explor'n Inc.)	082FNE107, 089, 112	Fort Steele, Golden	82F/16E	Zn, Pb, Ag	Sedex	geochemistry; mapping
Jubilee Mountain (WWC Consulting Ltd.)	082KNE079	Golden	82K/16W	Barite	Veins, breccias	2 adits; bulk sample; diamond drilling
Kootenay West (Westroc Inc.)	082JSW005	Golden	82J/4E	Gypsum	Evaporite	diamond drilling
Line Creek Mine (Luscar Ltd.)	082GNE020, 021, 022	Fort Steele	82G/15W, E	Coal	Coal	60 rdh, 9000 m
Loop Ridge (Fording Coal Ltd.)	082GNE009	Fort Steele	82G/10W	Coal	Coal	22 rdh, 4748 m
North Findlay (Eagle Plains Res. Ltd., Billiton Exploration Canada Inc.)	082KSE060, 081	Golden	82K/1E	Pb, Ag, Zn	Sedex	6 ddh, 1617 m; geochem.; mapping
Pakk/Pit (Chapleau Resources Ltd.)	082FNE074, 062	Fort Steele	82F/9E, W	Zn, Pb, Ag	Sedex	10 ddh; geochem.; prospecting ~ 2500 m
Pyramid Peak (Rio Algom Exploration Inc.)	N/A	Fort Steele	82F/9E	Zn, Pb, Ag,	Sedex	1 ddh, 1005 m; mapping
Superior (International Mineral Resources Ltd.)	N/A	Slocan	82F/12W	Graphite	Metamorphic	9 ddh, 1300 m

The adjoining property to the south, centred on Doctor Creek, now named South Findlay, was explored by Rio Algom Exploration Inc., under option from Eagle Plains Resources Ltd., with a program of systematic mapping and lithogeochemistry focused on the trace of the Lower- Middle Aldridge contact (LMC). The LMC, which is the approximate stratigraphic position of the Sullivan orebody, is manifested on the property by a laterally extensive fragmental horizon which is locally anomalous in lead and zinc. Rio Algom has indicated its intention to drill at least three holes to test the LMC in 2000.

The Greenland Creek property, which adjoins South Findlay on the south, was optioned from Eagle Plains and explored in 1999 by Kennecott Canada Exploration Inc.. Kennecott spent $240 000 on comprehensive mapping and geochemistry. It reported having outlined a 3 by 1 kilometre anomaly with zinc-in-soil values in excess of 700 ppm and anomalous beryllium, bismuth and cadmium The company has indicated its intention to drill test the anomaly in 2000.

South and west of St. Mary Lake, Chapleau Resources Ltd. is aggressively exploring the Pakk property under option from Super Group Holdings Ltd.


Ministry of Energy and Mines
Kootenay Region
Major Exploration Projects
1999
1 Fording River Mine
2 Greenhills Mine
3 Line Creek Mine
4 Elkview Mine
5 Loop Ridge
6 Coal Mountain Mine
7 Crowsnest
8 Jubilee Mountain
9 Kootenay West
10 Four J
11 Paul-Mike
12 Bull River
13 North Findlay
14 Greenland Creek
15 Pyramid Peak
16 Pit
17 Pakk
18 Irishman
19 Cruz
20 Car
21 True Blue
22 Kaslo Silver
23 Superior
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● Coal
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Figure 4. Major Projects, Kootenay Region, 1999.

which, in turn, is managing the project for Chapleau. The large claim group was assembled during the summer of 1999 as a result of three important new showings discovered by prospectors Craig, Tom and Mike Kennedy in an area of rugged topography and difficult access. The Lower Jack showing is a widespread accumulation of large, angular float boulders, well mineralized with pyrrhotite, sphalerite, galena and arsenopyrite, and displaying strong hydrothermal alteration. The Upper Jack zone consists of extensive tourmalinized and mineralized fragmental rocks in outcrop, and the Sinclair showing displays thin, stratabound layers of sphalerite and pyrrhotite in a mudstone unit 60 metres thick. Soil geochemistry has outlined an intense zinc-lead-arsenic anomaly extending about 3.4 kilometres northeast (believed to be down-ice) from the Lower Jack zone. The geology of the area is complex and still poorly defined but early indications are that the showings are all stratigraphically close to the Sullivan horizon and relatedto a major hydrothermal vent structure. Late-season diamond drilling consisted of seven short holes which tested each of the new showing areas and the previously known Polly vent. Results were encouraging and support the concept of a major hydrothermal vent on the property. A resumption of drilling is expected early in 2000. Chapleau is also exploring a property called Pit, optioned from Black Bull Resources Inc., which adjoins the Pakk claims on the northeast and extends along both sides of the St. Mary River valley to connect with the south end of the Sullivan mine property. It includes Black Bull's large Horn group of claims. Three diamond-drill holes were completed late in the year and more drilling is expected early in 2000.

In 1998, Ascot Resources Ltd. optioned the large Cruz property, located south of Moyie Lake, from Chapleau Resources Ltd. The property contains a large, untested zinc-in-soil anomaly and numerous indications of Sullivan-type hydrothermal alteration, fragmental zones and vent structures in Middle Aldridge rocks. The Ascot option was terminated in August of 1999 and Chapleau proceeded to explore the property itself, culminating in a modest late-season diamond drilling program, the results of which have not been announced. The joint venture of Chapleau Resources Ltd. with Black Bull Resources Inc.explored the Car property located east of Creston at the head of Russell Creek. The 1996 B.C. government-financed airborne geophysical survey located a large aeromagnetic anomaly coincident with a lead-zinc-silver-bearing fragmental zone in outcrop. Six drill holes, totalling 2309 metres, tested the zone and outlined a unit of pyritic, sericitized fragmental rocks 150 metres thick, interpreted as confirmation of a significant hydrothermal alteration zone requiring further work.

The Irishman property, which straddles the divide between the upper Moyie River and the Kid Creek drainages northwest of Creston, was optioned by Black Bull Resources Inc. from Sedex Mining Corp. Under a previous joint venture arrangement with Sedex in 1997, Kennecott Canada Exploration Inc. intersected 2.55 metres of semimassive sulphides grading 9.65% Zn, 5.82% Pb and 40.4 g/t Ag while drilling on the edge of a suspected hydrothermal vent field in Panda Basin at the head of Lewis Creek. In 1999, Black Bull drilled a hole offset by about 23 metres from the Kennecott hole and failed to intersect the massive sulphides, suggesting that they are a localized replacement rather than stratabound mineralization. The 1997 Kennecott hole was also lengthened to a depth of 1187 metres and intersected 40 metres of tourmalinized mudstones at the interpreted Sullivan stratigraphic horizon. The third and final hole consisted of deepening a hole drilled by Cominco Ltd in 1980 and believed to have stopped short of the Sullivan horizon. The results of that hole have not yet been released. Elsewhere on the property, trenching in upper Kid Creek exposed a siliceous shear zone up to 4.5 metres wide containing low-grade gold.

Other projects of note in the Purcell sedex search included Pyramid Peak at the head of Matthew Creek west of Sullivan mine and the Yahk property northeast of the community of Yahk, both of which were explored by Rio Algom Exploration Inc. under option from Abitibi Mining Corp.. At the former, one 1005-metre hole was drilled to test the Sullivan horizon in an interpreted sub-basin immediately west of the one which hosts the Sullivan orebody, and, at the latter, a single hole tested a hydrothermal vent zone near Mt. Mahon. Ascot Resources Ltd. optioned the Smoker property just west of Moyie Lake from Chapleau Resources Ltd. and drilled one hole to test the Sullivan horizon adjacent to the Smoker fragmental "vent". The hole was terminated when it intersected a thick Moyie gabbro sill at its intended target depth. Early in the year, Dia Met Minerals Ltd. completed a deep vertical diamond-drill hole on its Paul-Mike property near Wasa. The hole was started in 1998 to test a large seismic anomaly and coincident IP anomaly, believed to indicate the presence of a massive sulphide deposit. At the interpreted depth of the seismic anomaly, it intersected a thick, altered and mineralized gabbro sill but it was decided to continue drilling to test the Lower-Middle Aldridge contact (Sullivan horizon). The hole was finally completed in February of 1999 at a depth in excess of 1000 metres but results and the final depth have not been announced.

OTHER METAL PROJECTS

In the Flathead River area southeast of Fernie, the joint venture of Eastfield Resources Ltd. and International

Curator Resources Ltd. explored its Crowsnest gold prospect. Mineralization consists of low-grade, disseminated gold in sedimentary rocks and Cretaceous alkalic intrusions in a complex structural block known as the Howell Creek Structure. The Crowsnest property is located on Trachyte Ridge at the south end of the structure and is characterized by an abundance of high-grade gold-bearing boulders of syenite and magnetite-rich syenite breccia found in the overburden. One of several trenches (Photo 1) excavated by the joint venture exposed material similar to that in the boulders which returned 8.6 g/t Au over 16.5 metres. Ten diamond-drill holes, totalling 1096 metres, tested strong IP anomalies in the area interpreted to be the source area of the boulders. All of the holes intersected a complex array of syenite intrusions and pervasive silicification, pyritization and sericitization of the syenite and the dominantly limestone hostrocks. No high-grade material was encountered in the drilling but two of the holes returned thick sections (46.25 metres and 65.69 metres) of anomalous gold to a maximum of 330 ppb in syenite and 200 ppb in altered carbonate. In July, Eastfield optioned the Howell claims from Cominco Ltd. and Placer Dome Ltd. and mounted a late-season surface examination of the property involving mapping and rock sampling. The Howell claims are located at the north end of the Howell Creek Structure, only a few kilometres northwest of the Crowsnest property, and display similar geology and low-grade gold mineralization.

At the Bull River property, east of Cranbrook, the Stanfield Group of companies reported an expenditure of several million dollars on continued exploration of its extensive claim holdings centred on the old Bull River (Dalton) copper mine where Placid Oil Co. produced copper, silver and gold from two small open pits between 1971 and 1974. An exploration decline, collared within one of the open pits, has been advanced a distance of close to 3 kilometres from the portal. In addition, crosscuts on several levels have exposed the mineralized vein structures in preparation for bulk sampling. Diamond drilling consisting of forty underground and five surface holes are reported to have been completed during 1999. Smaller drilling programs were reported to have been conducted on other zones of interest on the claims, including the Aspen feldspar prospect near Fort Steele. Mineralization at the Bull River mine consists of chalcopyrite, pyrite and pyrrhotite, with minor galena and arsenopyrite, hosted in structurally complex quartz-carbonate veins and silicified shears up to 6 metres wide. A geological description of the Bull River mine, together with detailed results of a Ministry of Energy and Mines sampling program on the mineralized veins, conducted in 1999, has been published in Geological Fieldwork 1999, Paper 2000-1.

Photo 1. Mineralized trench, Crowsnest project.

On Keen Creek, west of Kaslo, Cream Minerals Ltd. conducted major exploration programs on its optioned Kaslo Silver high grade silver-lead-zinc prospect in 1997 and 1998. Two types of mineralization, including disseminated sulphides in sheared argillites and massive replacement zones in limestones of the Slocan Group, occur in numerous showings and small former producing mines for a distance of 9 kilometres along two major northeast-trending shear zones. In 1999, only a modest program was completed, consisting mainly of about 360 metres of diamond drilling on the Bismark and Black Bear zones, and collection of a small bulk sample from the Silver Bear shear zone for metallurgical testing. Immediately southwest of the village of Kaslo, Sultan Minerals Inc. drilled one short hole (Photo 2) at the optioned True Blue polymetallic, volcanogenic massive sulphide occurrence in Milford Group rocks. The hole was intended to test the down-plunge continuity of the high-grade surface showing. Although it intersected a 2-metre section of the same mineralized sericite schist, grades were less than anticipated. Down-hole geophysics failed to indicate any significant extension of the zone, so the program was discontinued after the first hole. Sultan Minerals also completed detailed mapping and geophysics over the large Wilson Creek zinc-silver-barium soil anomaly east of the former Jersey and Emerald mine workings on its Jersey-Emerald property south of Salmo. Trenching and drilling of the Wilson Creek anomaly and other zones of interest are anticipated in 2000.

South of Silverton, on Slocan Lake, a private partnership called Lucky Dog Prospecting completed a geophysical survey and drilled one deep hole and two shorter holes, for a total of about 1200 metres, on its Lucky Dog property. The target is gold and other metals associated with shears and silicified breccias in the hanging-wall of the Slocan fault, a regional feature generally described in current literature as a major, east-dipping detachment fault flanking the east side of the Valhalla metamorphic core complex.

Indo Metals Ltd. completed a brief program of mapping and geochemical sampling on the Oxide property optioned from Cominco Ltd. and located on the ridge between Porcupine and Oscar creeks, north of Salmo. Mineralization on the property consists of high zinc and lead values in a north-striking shear zone up to 23 metres wide and at least 1 kilometre in strike length. The metals are present entirely as oxides disseminated within unconsolidated, limonitic material which has been traced for several tens of metres below surface within the shear zone. A channel sample taken by Cominco in 1998 returned 14% Zn across 5 metres and individual grab

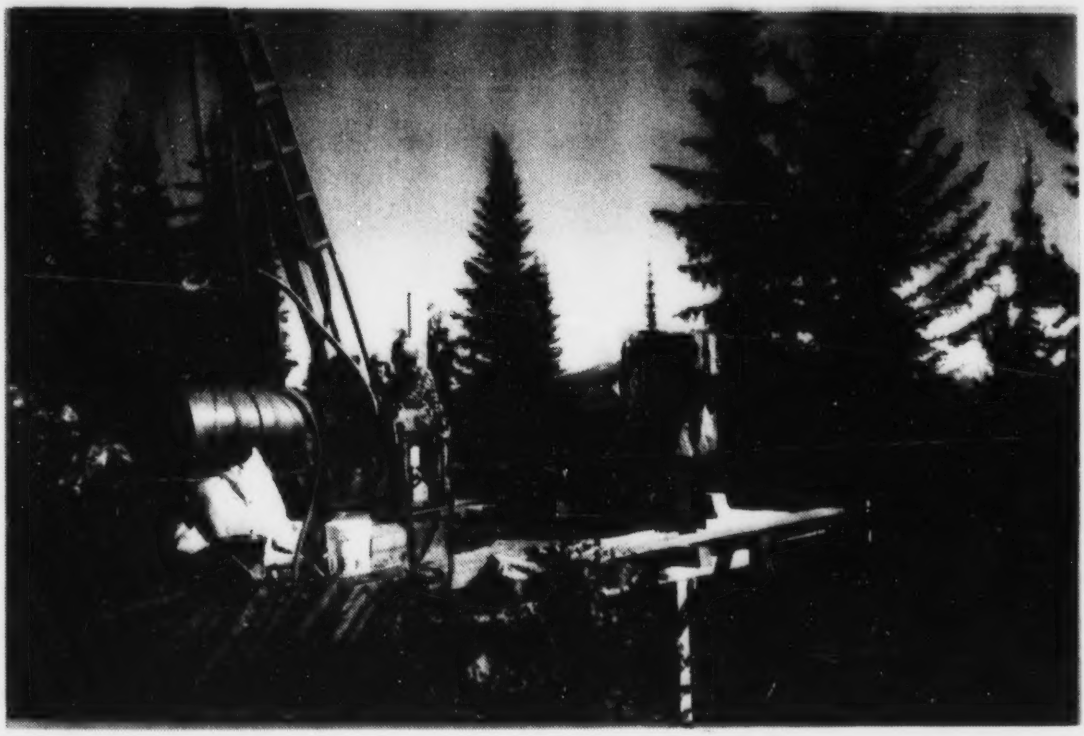

Photo 2. Drilling at True Blue property.

samples ran as high as 53% Zn. Indo Metals is involved in a research project with Lakefield Research Ltd. to develop a new technique for treatment of zinc oxide ores. The company has indicated its intention to test the zone by diamond drilling in 2000.

The Greenwood Mining Division saw some sustained prospecting activity in 1999, primarily targeting gold and including five programs which were partially funded by prospector grants from the Ministry of Energy and Mines. One of those grant-supported programs was at the former Gold Drop mine, east of Jewel Lake, where Ed Brown carried out underground exploration drifting and surface prospecting, testing for extensions of the gold-bearing Gold Drop quartz vein. One other minor project in the Greenwood area involved limited trenching by Century Gold Corporation at the Golden Crown gold property southeast of Phoenix.

INDUSTRIAL MINERALS

The Parson barite mine, south of Golden, operated by Highwood Resources Ltd., closed permanently during 1999, having exhausted its reserves. On Jubilee Mountain, west of Spillimacheen and about 16 kilometres southeast of the Parson mine, W.W.C. Consulting Ltd. explored a series of barite veins (Photo 3) on a property optioned from prospector Art Louie. The veins were explored underground with two short adits and a raise, as well as some short, surface diamond-drill holes. Barite from the underground openings was transported to the company-owned mill on Madias Creek south of Windermere for testing.

Westroc Inc., which operates the Elkhorn gypsum quarries on Windermere Creek, continued with a program of systematic drilling and mapping to explore the gypsum resources on its Kootenay West property, located on the Kootenay River northeast of Canal Flats. Southeast of Canal Flats, Georgia Pacific Canada Inc., which mines gypsum from its Four J quarry on Lussier River southeast of Canal Flats, completed reserve definition drilling totalling over 2000 metres in 51 diamond-drill holes adjacent to the east side of the operating quarry. The company also carried out small drill tests on three other gypsum properties it owns upstream on Lussier River.

Stralak Resources Inc. has optioned the Marysville Magnesite property south of Kimberley from Cominco Ltd. and recovered a small bulk sample of magnesite for quality testing in eastern Canada. South of Bridesville, in the Boundary area, ProAm Explorations Corporation completed about 250 metres of core drilling at the Bridesville Silica prospect to collect material for quality testing.

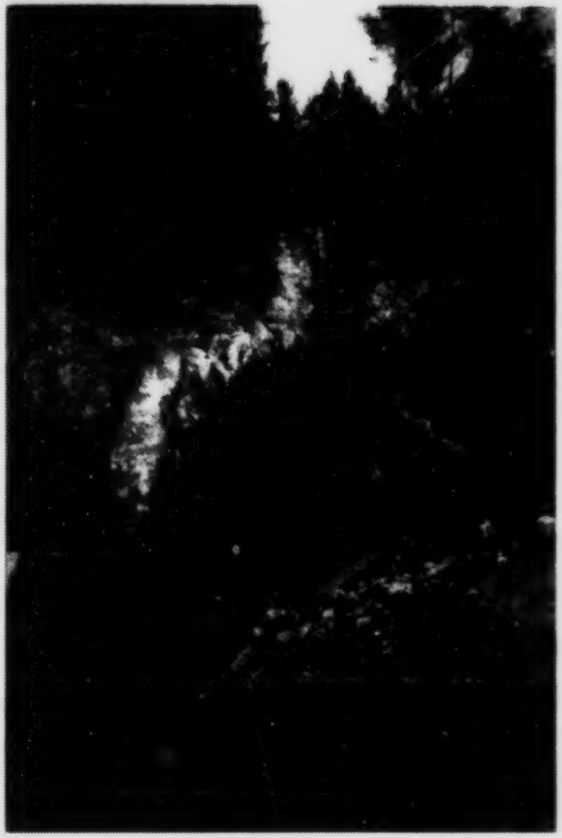

Photo 3. Barite vein, Jubilee Mountain.

The Ice diamond prospect, on the west side of the Elk Valley at Elkford, was optioned in 1999 from Quest International Resources Corp. by Skeena Resources Ltd. A stream sediment sampling program has been completed and trenching is proposed to further sample two of the kimberlite zones discovered by Quest in 1994. After two years of aggressive exploration and marketing activity in 1997 and 1998 at its Blu Starr and other gemstone prospects in the Slocan Valley, Anglo Swiss Resources Inc., in 1999, limited its activities to some additional prospecting and geological studies early in the year, followed by recovery of a small bulk sample from one of its iolite zones near Passmore.

On Hoder Creek, west of Slocan, International Mineral Resources Ltd. diamond drilled the Superior graphite property. Flake graphite is disseminated in a marble unit within the Valhalla gneissic complex and, to a lesser extent, in the associated quartz-feldspar-biotite paragneisses.

COAL

All five of the producing coal mines in the Elk Valley completed programs of in-pit exploration drilling in 1999, to firm up reserves and test coal quality. The largest mine, Fording River, operated by Fording Coal Ltd., limited its drilling to eight holes totalling 2000 metres. Fording's Greenhills operation drilled 3032 metres in 34 holes and its Coal Mountain mine drilled over 10 000 metres in 90 holes. Luscar Ltd. completed 9000 metres in 60 holes at its Line Creek mine and Elkview Coal Corp. drilled 66 holes totalling 7000 metres at the Elkview mine.

The only drilling program carried out in 1999 that was not directly associated with an operating mine was at Loop Ridge on Michel Creek, south of the McGillivray pit, where Fording Coal Ltd. completed 22 reverse-circulation holes totalling 4748 metres. The metallurgical coal at Loop Ridge and at McGillivray occurs in seams structurally thickened against the regional Erickson fault.

PRODUCING MINES AND QUARRIES

COAL

In spite of poor world markets and low prices, the five producing coal mines in southeastern British Columbia maintained production through 1999 with some scheduled, temporary shutdowns and only limited work force reductions. The total clean coal production from the Southeast mines in 1999 is estimated at 20.3 million tonnes.

Fording Coal Ltd. operates three of the mines and is expected to account for about 74% of the total production. The largest mine, Fording River, will produce around 8.5 million tonnes, about the same as in 1998, most of it coming from the Eagle Mountain and Henretta pits. The nearby Greenhills mine expects production to total 4.2 million tonnes, a slight increase over 1998. Both of these mines instituted a three week summer shutdown but there were no significant reductions in the work force. At its Coal Mountain mine on Michel Creek, Fording increased its production from 1.88 million tonnes in 1998 to an estimated 2.3 million tonnes in 1999.

At its Line Creek mine, Luscar Ltd. expects total sales of 1.9 million tonnes of metallurgical coal and 0.5 million tonnes of thermal coal, an overall reduction of about 20% from 1998 sales. As a consequence of reduced sales and a need to improve mining costs, there was a work force reduction of 65 union and 15 staff employees during the year. Elkview Coal Corporation, at its Elkview mine east of Sparwood, expects production to total 2.9 million tonnes, a small reduction from 1998. Early in the year, the company instituted reduced work weeks and a number of scheduled one-week shutdowns, but later, following an improvement in sales prospects, those measures were discontinued.

METALS

The only producing metal mine in the Kootenay region is Cominco Ltd.'s Sullivan zinc-lead-silver mine at Kimberley. The Sullivan orebody, at about 160 million tonnes, was one of the world's largest single massive sulphide deposits. It is an exhalative sedimentary deposit occurring in the Middle Proterozoic Aldridge Formation of the Purcell Supergroup. Reserves are almost depleted and the mine is scheduled to close at the end of 2001. At January 1, 1999, Cominco reported the remaining reserves to be 6.1 million tonnes grading 6.6% Zn, 3.7% Pb and 20 g/t Ag. The mine is expected to maintain its current production rate of about 2 million tonnes per year right up to the date of its closure. During 1999, underground drilling continued to evaluate remaining ore remnants, and the feasibility of recovering a small zone of mineralization in the original open pit was being reviewed.

TABLE 2. PRODUCING MINES AND QUARRIES, KOOTENAY REGION, 1999

MINE	OPERATOR	DEPOSIT TYPE	FORECAST PRODUCTION	RESERVES (Jan 1, 1999)
Coal Mountain	Fording Coal Ltd.	Coal	2.3 million tonnes	
Elkview	Elkview Coal Corporation	Coal	2.8 million tonnes	
Fording River	Fording Coal Ltd.	Coal	8.5 million tonnes	
Greenhills	Fording Coal Ltd.	Coal	4.2 million tonnes	
Line Creek	Luscar Ltd.	Coal	2.4 million tonnes	
Sullivan	Cominco Ltd.	Sedex	approx. 2 million tonnes	6.1 million tonnes @ 6.6% Zn, 3.7% Pb, 20 g/t Ag
Mount Brussilof	Baymag Mines Co. Ltd.	Replacement	approx. 200,000 tonnes magnesite	
Elkhorn	Westroc Inc.	Evaporite	500,000 tonnes gypsum	

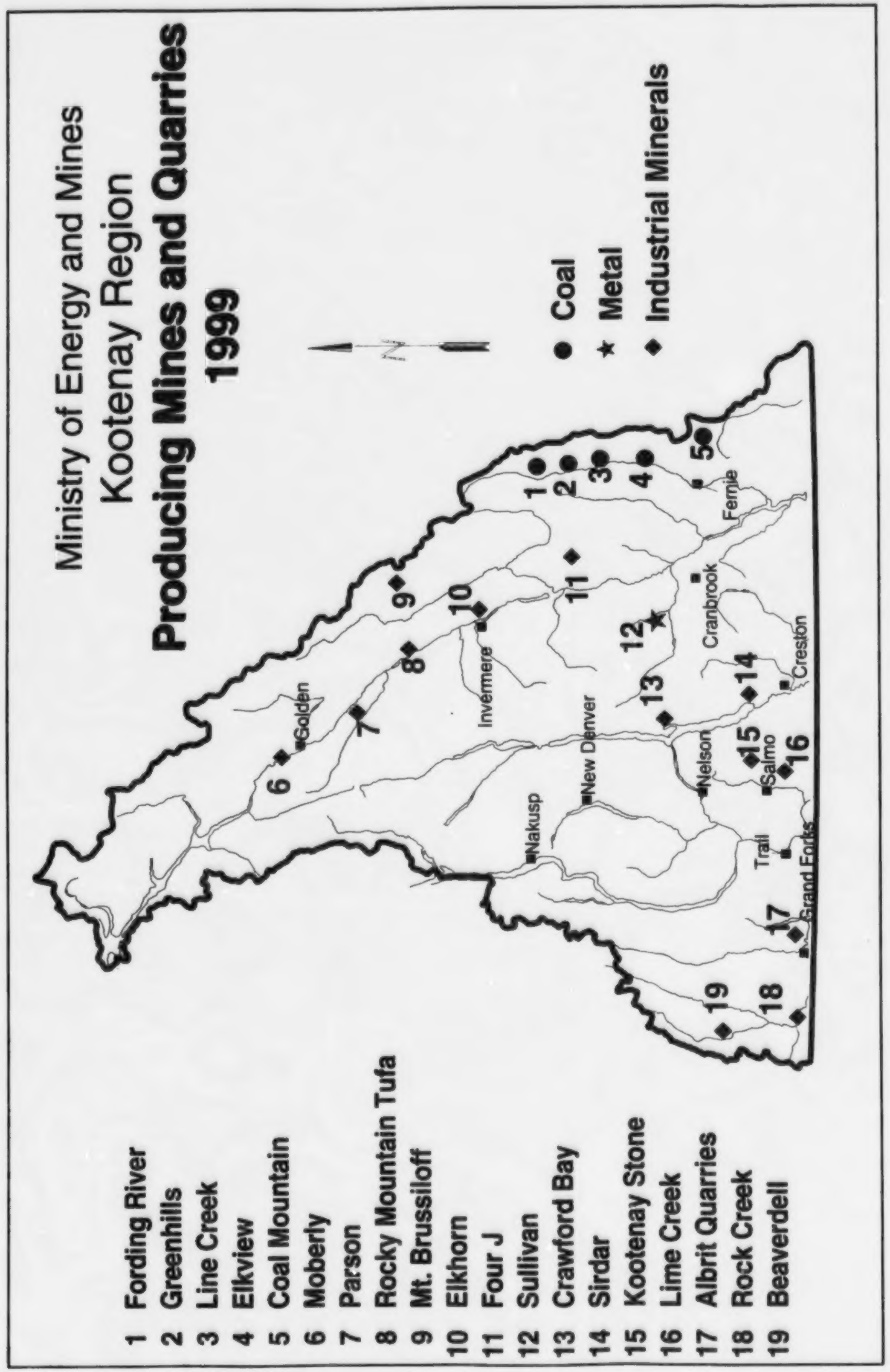
Ministry of Energy and Mines
Kootenay Region
Producing Mines and Quarries
1999
N
● Coal
★ Metal
◆ Industrial Minerals
1 Fording River
2 Greenhills
3 Line Creek
4 Elkview
5 Coal Mountain
6 Moberly
7 Parson
8 Rocky Mountain Tufa
9 Mt. Brussiloff
10 Elkhorn
11 Four J
12 Sullivan
13 Crawford Bay
14 Sirdar
15 Kootenay Stone
16 Lime Creek
17 Albrit Quarries
18 Rock Creek
19 Beaverdell
Golden
Invermere
Cranbrook
Fernie
Creston
Nelson
New Denver
Nakusp
Salmo
Trail
Grand Forks

Figure 5. Producing Mines and Quarries, Kootenay Region, 1999.

INDUSTRIAL MINERALS

Westroc Inc. maintained steady production at its Elkhorn gypsum quarries near Windermere, shipping a total of about 500 000 tonnes of gypsum to its own wallboard plants in Vancouver and Calgary. Georgia Pacific Canada Inc. continued to mine gypsum from its Four J quarry on the Lussier River throughout the year, shipping it from its own rail-loading facility at Canal Flats. As noted above, both companies engaged in aggressive exploration of additional gypsum resources in the general area east of Canal Flats.

At its Mount Brussilof mine (Photo 4) northeast of Radium Hot Springs, Baymag Mines Company Limited produced approximately 200 000 tonnes of magnesite and shipped the material to its own processing plants at Exshaw, Alberta, where it is converted to various forms of sintered, calcined and fused magnesia. Highwood Resources Ltd. produced an estimated 120 000 tonnes1998, and remained closed through 1999, due to the closure of its only main purchaser, a silicon and ferrosilicon plant at Wenatchee. Also, as noted above, the Parson barite mine, operated by Highwood Resources Ltd., closed permanently during the year due to depletion of its reserves.

IMASCO Minerals Inc. processed and shipped a variety of specialized industrial mineral products from its plant at Sirdar, north of Creston. Raw materials include dolomite and limestone mined at its underground Crawford Bay operation, and from its small Lime Creek quarry south of Salmo. The company also produces crushed granite and quartzite products from material mined at Sirdar and near Crawford Bay.

Mighty White Dolomite Ltd. quarries and processes dolomite near Rock Creek. Kootenay Stone Centre, near Salmo, and a few other operators, produce a variety of colours and patterns of quartzite flagstone from several small quarry operations, mainly on Porcupine Creek, but also at Duncan Lake and south of Castlegar. Granite dimension stone is intermittently mined from two quarries south of Beaverdell, the larger one operated by Quarry Pacific Industries Ltd.

At Brisco, north of Radium Hot Springs, the Wolfenden family has developed a very profitable business, which they call Rocky Mountain Tufa, mining tufa off their fields and marketing it across Canada and the United States. The tufa is being continuously deposited by calcium carbonate charged water overflowing from cold springs at the base of the limestone mountains east of the village. It is easily peeled directly from the surface in slabs, loaded onto pallets and

Photo 4. Mount Brussilof Magnesite Mine.

sold to landscaping and gardening stores for use in constructing alpine gardens. It is marketed now in Calgary, Vancouver and as far away as Montreal and New York City. They estimate having sold about 1000 short tons in 1999 at a price of $240/ton f.o.b. Brisco.

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Most of the data relating to coal exploration and mining was acquired and shared with the author by Barry Ryan of the Geological Survey Branch. The author also gratefully acknowledges the assistance of his colleagues in the Cranbrook regional office, particularly Maggie Dittrick and Valerie Smolik, who helped with preparation of the report and its illustrations.

This paper was significantly improved by editorial comments from John Newell, and, last but not least, thanks are due to Bob Lane, Regional Geologist at Prince George, for compiling the total volume and preparing it for publication.

PART B

GEOLOGICAL DESCRIPTIONS OF SELECTED PROPERTIES

PROSPECTORS ASSISTANCE PROGRAM

APPLIED GEOCHEMISTRY

WADSWORTH VEIN

By Paul J. Wojdak, Wayne Bulmer and Daryl J. Hanson

LOCATION:	Lat. 54°57'33"N Long. 128°50'09"W (103I/15W) SKEENA MINING DIVISION. The property is located in the Cedar River valley north of Kitsumkalum Lake, 50 kilometres north of Terrace, British Columbia.
CLAIMS:	HOPE 1, 2, ORE 3, 4, HELL 2, LADY, LADY 2, FALL 4, YUFFY 2 (9 units) Referred to in this report as the Hope claim group.
ACCESS:	North from Terrace for 45 kilometres on Nass highway; north on the radio-controlled Cedar forest service road to Kilometre 5.5, and 0.5 kilometres on the 100 branch road to the property.
OWNER/OPERATOR:	Wanita Hansen (51%) and Paul Wadsworth (49%)
DEPOSIT TYPE:	Intrusive-related gold quartz vein
COMMODITIES:	Gold, tungsten

GEOLOGIC SETTING OF THE WADSWORTH VEIN: AN INTRUSIVE-RELATED GOLD DISCOVERY NEAR TERRACE, B.C.

INTRODUCTION

Veteran prospector Paul Wadsworth discovered spectacular coarse gold in a quartz vein on May 23, 1998. The vein is exposed on a logging road where a small amount of rock was quarried for road building. The showing is on the western flank of the Nass Ranges at the eastern edge of a broad valley, at an elevation of about 500 metres on the Hope 2 mineral claim (Figure 1).

HISTORY

The area was previously explored as the Big Joe claims (103I 023). Molybdenum mineralization was discovered in 1966 during construction of logging roads and the Big Joe claims were optioned from E.R. Anderson and I. Remillong by Silver Standard Mines Ltd. (Burmeister, 1966). Mapping by Carter (1972) indicates the best molybdenite occurrence is about 125 metres southwest of the Wadsworth gold vein. Silver Standard filed a molybdenum soil survey for claim assessment and the following year dug eight bulldozer trenches totaling 2500 metres in length. In 1971, the Big Joe claims were acquired by ASARCO but there is no record of its work, nor of subsequent exploration activity, until Paul Wadsworth's discovery. Mr. Wadsworth hand-mined the vein over a 14-metre length to a depth of about 1 metre and hand-sorted the vein. At an average width of 5 centimetres, this represents about 2 tonnes of material, which was placed into 5-gallon pails.

GEOLOGIC SETTING

The geology shown in Figure 1 is taken from *The Map Place*, the Ministry web site. The Hope claims are near the southern margin of the Middle Jurassic Bowser Lake Group sedimentary basin which overlaps Stikine Terrane, and the claims are less than 10 kilometres from the Coast plutonic complex. The claim area is underlain by grit, greywacke and siltstone of the Bowser Lake Group (Woodsworth et al., 1985). These are intruded by a granodiorite stock which is typical of the granitic rocks on the eastern flank of the Coast plutonic complex, that yield K-Ar age determinations between 45 and 50 million years (Carter, 1971). The property is at the north end of a Tertiary graben 100 kilometres long, the Kitimat Trench. This prominent topographic feature is 5 to 10 kilometres wide. South of the Hope claims, the Kitimat Trench is occupied by Kitsumkalum Lake and the Cedar River, and to the north it terminates against the Nass mountain range.

GEOLOGY OF THE WADSWORTH VEIN

Hostrocks to the Wadsworth vein are coarse grit, with pebbles to 1 centimetre in size, and greywacke with metamorphic muscovite on bedding plane partings. At the showing, these strata strike at 060° and dip 30° to the southeast. The Wadsworth vein strikes at 175°, dips 80° to the east, and is very close to the southern contact of a northeast-elongate granodiorite stock, mapped by Carter (1972). There is a large outcrop of well-jointed granodiorite on the logging road about 150 metres south-

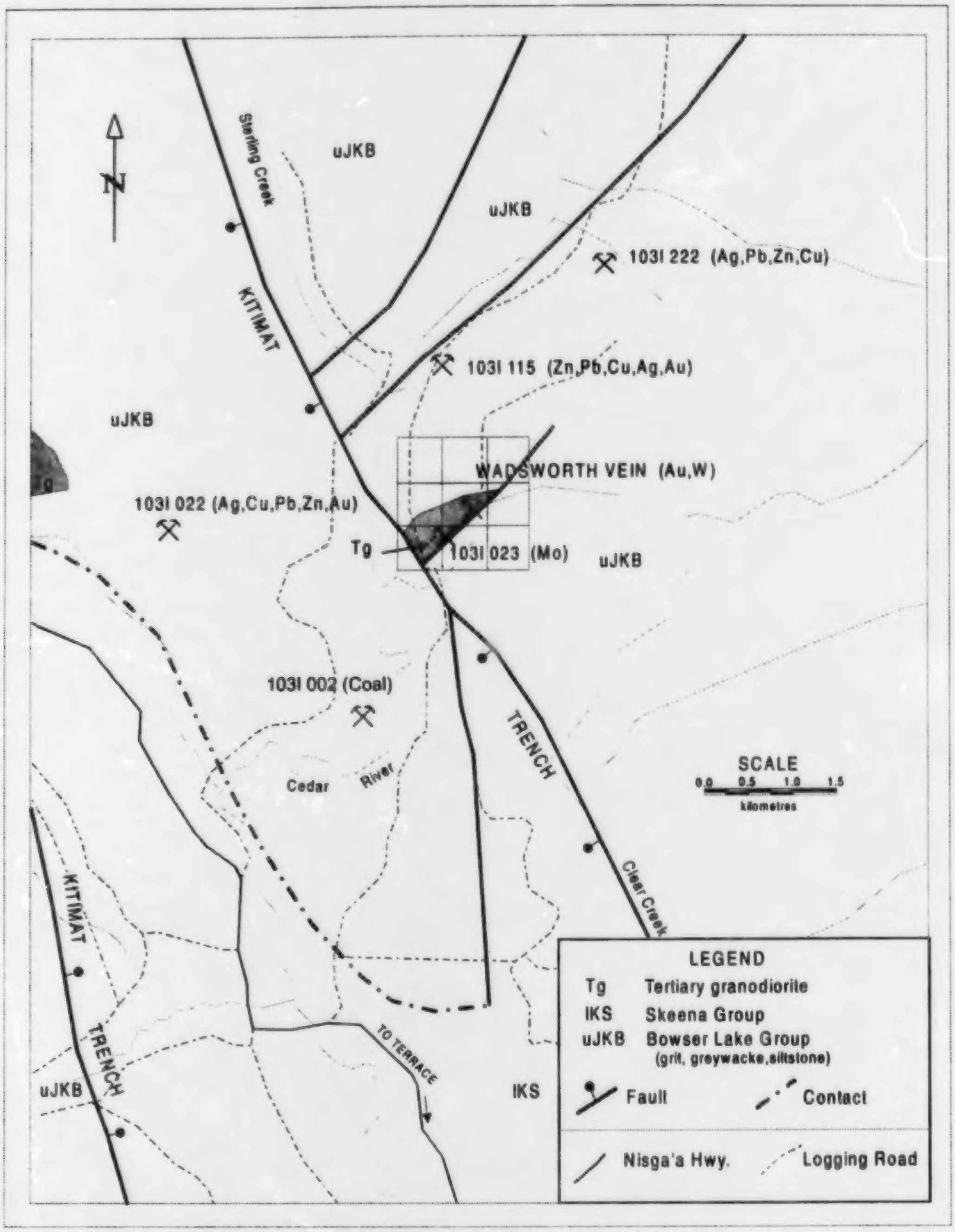
N
Sterling Creek
uJKB
uJKB
103I 222 (Ag,Pb,Zn,Cu)
KITIMAT
103I 115 (Zn,Pb,Cu,Ag,Au)
uJKB
WADSWORTH VEIN (Au,W)
103I 022 (Ag,Cu,Pb,Zn,Au)
Tg
103I 023 (Mo)
uJKB
103I 002 (Coal)
TRENCH
Cedar
River
SCALE
0.0 0.5 1.0 1.5
kilometres
Clear Creek
KITIMAT
TRENCH
TO TERRACE
uJKB
IKS
LEGEND
Tg Tertiary granodiorite
IKS Skeena Group
uJKB Bowser Lake Group
(grit, greywacke, siltstone)
Fault
Contact
Nisga'a Hwy.
Logging Road

Figure 1. Hope claims, Location and Area Geology.

west of the vein. Carter reports that molybdenite is confined to the granitic rocks where it occurs as selvages along widely spaced quartz veins, 1 to 2 centimetres wide, as disseminations in aplite stringers, and as coatings on fracture planes with sericite. The stock measures 800 by 300 metres, and has a thermal metamorphic aureole 45 to 60 metres wide expressed as extensive biotite hornfels, a radiating fibrous amphibole immediately adjacent to the contact, and a thin band of light green quartz-epidote-garnet skarn along the southern contact (Carter, 1972). Muscovite observed by the senior author strongly suggests the Wadsworth vein is within the metamorphic aureole, i.e. less than 60 metres from the granodiorite stock. Carter reports the best molybdenum mineralization in surface exposures was seen along the main logging road near the south contact of the stock. He also notes that the regional northeast strike of the sedimentary rocks has been arched around the intrusive contact, and interprets this as evidence of its forceful emplacement. The stock was emplaced along a northeast-striking fault which, apparently, terminates against the Kitimat Trench.

The Wadsworth vein varies in width from 1 to 10 centimetres, and consists of at least 75% coarse, milky quartz and 20% pink to flesh-coloured scheelite grains averaging 0.5 centimetre in size. Well-formed cubes of pyrite, sporadic concentrations of coarse galena and spectacular, coarse native gold comprise the balance, less than 5%. Observable wallrock effects are minimal. There is, however, a discontinuous selvage of heavily disseminated pyrite on the footwall of the vein that is, at most, a few centimetres wide. The vein is exposed over a strike length of about 15 metres. To the south it is covered by rock fill in the road bed, and to the north by dense vegetation and thin overburden. The outcrop of Bowser Lake Group sedimentary rocks is cut by several other narrow quartz veins with a similar trend to the Wadsworth vein, but these do not contain visible scheelite or gold. The outcrop is also transected by granitic dikelets, less than a metre wide, with steep dips and irregular strikes. Flat quartz veinlets, without visible scheelite, sulphides or gold, crosscut the granite dikelets. The prominent joint set in the granodiorite strikes northwest and dips 70° northeast, but is not filled by quartz veins.

Six channel samples were taken at 3-metre intervals by W. Bulmer, assisted by Paul Wadsworth, beginning at the north end of the outcrop exposure (Figure 2). Each sample extended about 0.3 metres into the wall rock on either side of the vein, producing a 0.6-metre sample. Vein material and wallrock were then separated and each portion was analyzed separately at Min-En Laboratories. Eleven samples were analyzed geochemically for gold and the sample at 9 metres south, which contained free gold, was subjected to a metallic assay. All vein samples were assayed for tungsten. The data clearly show that gold is present predominantly as free gold within the quartz vein and, on the basis of this small dataset, gold does not correlate with tungsten.

Wanita Hansen collected five samples of the vein along its length, consisting of only vein material with no wallrock. These were subjected to ICP analysis at Acme Analytical Laboratories. The arithmetic average of the five samples is listed in Table 2. Together with the data in Table 1, the Wadsworth vein is considered highly anomalous in Au, Ag, W and Pb, moderately anomalous in Bi, and weakly anomalous in Mo, Cu, Zn and Sb. The proximity of molybdenite mineralization indicates that Mo can be considered highly anomalous at a property scale.

Table 1 Wadsworth Vein Analytic Data

Vein Interval	Gold in Wallrock	Gold in Vein	Tungsten in Vein
0 m South	6 ppb	16 ppb	10.5%
3 m South	5 ppb	14 ppb	17.3%
6 m South	338 ppb	27 ppb	2.31%
9 m South	1840 ppb	10 993 grams/tonne	0.78%
12 m South	11 ppb	792 ppb	0.34%
15 m South	36 ppb	33 ppb	2.23%

Table 2 Wadsworth Vein Trace Element Data by ICP Analysis

Mo	Cu	Pb	Zn	Au	Ag	Ni	Co	As	Sb	Bi	Sn
17 ppm	73 ppm	6907 ppm	308 ppm	5 ppm*	44 ppm	10 ppm	2 ppm	7 ppm	11 ppm	26 ppm	<2 ppm

*Analytic method is inappropriate for Au, see Table 1.

Figure 2. Paul Wadsworth sampling the Wadsworth vein.

REGIONAL POTENTIAL

Several mineral occurrences, in addition to Big Joe (103I 023), are listed in MINFILE within 3 kilometres of the Wadsworth vein. None have been examined by the authors and their locations shown on Figure 1 are extracted from MINFILE and have not been verified. Three showings, 103I 022, 103I 115 and 103I 222, are northeast-striking, polymetallic quartz veins that cut Bowser Lake Group strata. The association of these vein occurrences with dikes suggests they are derived from igneous intrusions nearby. Silver, as tetrahedrite, is the primary commodity in two of the occurrences, and base metals are the primary commodities in the third. Gold is present, but as a minor constituent. Douglas Creek, 15 kilometres south of the Hope property, has recorded placer production of 10.9 kilograms (350 ounces) of gold between 1886 and 1940. No bedrock source for the placer deposits is recognized but Douglas Creek drains an area east of the Kitimat Trench that is geologically similar to the Hope property. Lefebure et al. (1999) recognize the Terrace area as being prospective for intrusion-related gold-tungsten-bismuth veins, based on the coincidence of gold-quartz veins, placer gold, tungsten veins and silt geochemical anomalies in gold and tungsten. Most of the showings occur in a well mineralized area east of Terrace. The Hope property is on the northwestern edge of this identified area. It should be noted that the regional geochemical survey of the Terrace (103I) map sheet does not include tin or bismuth, signature elements of intrusive-related gold deposits.

CONCLUSIONS

Gold mineralization on the Hope claims conforms to the model of intrusive-related gold deposits. The Wadsworth vein is closely associated with a molybdenum-bearing granodiorite stock and has the characteristic Au-Ag-W-Mo-Bi-(Pb-Sb-Cu-Zn) geochemical signature. The presence of high-grade gold suggests that the area has excellent potential for a large, "intrusive-related" gold deposit, such as Pogo and others in Alaska. Several showings nearby the Wadsworth vein merit re-examination to better assess their characteristics and exploration potential. The location of the Wadsworth vein at the north end of Kitimat Trench, and close association with the fault on its eastern margin, suggests that mineralized plutons and gold veins may be genetically linked with that structure. Faults and fractures related to the trench may have provided a preferred solution channelway and structural trap. The area of the trench-bounding faults and complementary northeasterly structures should be closely prospected.

ACKNOWLEDGEMENTS

The assistance of Wanita Hansen in obtaining and providing information assisted greatly in the preparation of this report.

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ZYMO PROPERTY (093L 324)

By Brett LaPeare, Paul Wojdak, Daryl Hanson

LOCATION:	Lat. 54°58'N Long. 127°57'E (93L/13) OMINECA MINING DIVISION. The property is located on Mulwain Creek, which is a tributary flowing into upper Zymoetz (Copper) River. The centre of the property is approximately 50 km west of Smithers.
CLAIMS:	Zymo 1 through 16
ACCESS:	1) Vehicle - 17 km from Smithers along Hudson's Bay Mtn. Rd to the McDonnell forestry service road – west on McDonnell forestry service road which intersects the north boundary of the claim group at 54 km; 2) Helicopter – due west of Smithers (approx. 0.4 hr)
OWNER:	Joint Venture: 811537 Alberta Ltd. and Freeport Copper Company
OPERATOR:	Freeport Copper Company, a subsidiary of Freeport McMoRan Copper and Gold Inc.
DEPOSIT TYPE:	Porphyry copper-gold
COMMODITIES:	Copper, gold, silver, lead, zinc

A SUMMARY OF EXPLORATION WORK AND GEOLOGY OF THE ZYMO PORPHYRY CU-AU PROSPECT

INTRODUCTION

In 1998 Freeport Copper Company (FCC), a subsidiary of Freeport McMoRan Copper and Gold Inc., entered into a option agreement with 811537 Alberta Ltd. to carry out exploration on a porphyry copper-gold target located on the Zymo claims. In 1999 FCC completed a diamond drilling program consisting of six vertical holes totaling 1482 metres. Drilling focused on an area defined by a copper soil anomaly located immediately south of a chalcopyrite and bornite-mineralized outcrop exposed by a north-flowing stream. Exploration of the Zymo claims by Robin Day and Larry Hewitt, assisted by a B.C. Prospector's Assistance Grant, was instrumental in leading to the option agreement.

HISTORY

In 1986, a 193 ppb gold anomaly was identified in a silt sample taken from a creek draining the project area (Open File 1361-RGS 97-1986). In 1988, Corona Corporation, while working on the Louise Lake property (7 km to the east of Zymo claims) staked one claim over the drainage area of the RGS silt anomaly. Corona prospected the claim and collected rock, soil and silt samples that exhibited weakly anomalous gold values. A partnership between Skeena Resources Ltd., and Leeward Capital Corp., staked the Red claims in 1990. A one day program in 1991, carried out by Taiga Consulting of Calgary, consisted of prospecting, geological mapping and collection of stream silt and rock samples. The program identified two narrow calcite veins (1cm and 5 cm) containing semi-massive galena and pyrite. Seven of the rock samples yielded anomalous gold values ranging from 112 to 650 ppb. Another sample assayed 0.26% Cu, 0.28% Pb and 0.54% Zn. A sample from a narrow quartz-calcite veinlet returned values of 3.7% Pb and 5.3% Zn. No further work was done on the property until 1996 when prospectors Robin Day and Larry Hewitt staked the Zymo 1 through 8 claims.

A prospecting program undertaken by Day and Hewitt included collection of rock, soil, stream silt and heavy mineral stream silt samples. Thirty-two rock samples returned gold values ranging from 200 to 6900 ppb. Copper content of stream silt samples ranged from 572 to 1697 ppm. Additional soil sampling outlined a 600 by 700 metre copper anomaly with soil values between 400 and 3870 ppm. This anomaly became the focus for the diamond drilling completed by Freeport Copper Company.

PHYSIOGRAPHY

The topography is gentle to moderate with elevations ranging from 2500 to 2900 metres in Mulwain and Red Canyon Creek valleys, to 3500 metres on the flat-topped ridge in the middle of the claims. Outcrop exposure is limited to where creeks have eroded into bedrock. Two north-flowing tributaries to Mulwain Creek cut across the sedimentary and intrusive rocks incising 10 to 75 metres into bedrock. Most of the property is covered by typical montane to sub alpine old-growth vegetation including western and mountain hemlock, fir and various alders and willow shrubs. Well defined, open grassy areas are scattered throughout the property. They occur as relatively flat, grassy swamps and do not support timber growth. The swampy areas locally exhibit ferricrete, occurring as limonitic clay-rich mud flats and/or small terraces (Figure 1). These open areas are significant in that underlying soil contains up to 3870 ppm Cu (see Table 1) and they are excellent sites for helicopter access and drill set-ups. All six drill sites were located within such swamps. Very little timber cutting was required to build drill pads, enabling work permits to be acquired quickly. Glacial moraine and colluvial till support forest growth, except in the grassy swamps where groundwater seepage results in deposition of oxidized iron-rich clay.

REGIONAL GEOLOGY

The Zymo claims are located within Stikine Terrane, part of the Intermontane Superterrane, near the western end of a transverse Mesozoic feature known as the Skeena Arch. The arch contains Middle Jurassic to Lower Cretaceous sedimentary and volcanic rocks and forms the southern boundary of the Upper Jurassic Bowser sedimentary basin to the north. The arch has been segmented by numerous block faults and some thrust faults. The claim area is underlain by sandstone, siltstone, shale, polymictic conglomerate and coal of the Kitsuns Creek Formation, part of the Lower Cretaceous Skeena Group. These siliciclastic sedimentary rocks were deposited in a shallow marine environment. The sedimentary succession is cut by stocks of the late Cretaceous Bulkley intrusive suite, of intermediate composition, and the Eocene Nanika granitic intrusions.

The Intermontane Superterrane contains the majority of porphyry copper deposits in British Columbia. In the Smithers area these include the Bell Copper, Granisle and Huckleberry mines and significant resources at the Berg, Poplar, Big Onion, Morrison, Hearne Hill deposits and Louise Lake, a 50 mt resource 7 km east of the Zymo property.

PROPERTY GEOLOGY

Conglomerate, sandstone and shale, and local thin andesite flows, underlie the Zymo property. Conglomerates are polymictic with well-rounded cobbles 5 to 15 centimetres in size. Conglomerate beds range in thickness from less than 50 to more than 100 metres.

Figure 2. Robin Day (raised arm) standing on one of the many ferricrete deposits that are found on the Zymo property.

TABLE 1. MAXIMUM GEOCHEMICAL VALUES, CENTRE OF SOIL ANOMALY

		Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)
22	550N/55W	28	<1	1464	2	242	204
23	550N/58W	17	<1	3870	173	674	85
24	550N/59W	117	<1	3288	346	856	1
25	575N/59W	38	<1	899	108	313	124

Sandstone and shale units range from 10 to 50 metres in thickness. The sandstone is massive to moderately jointed but shale units are generally highly fractured, especially along thin (1 cm) bedding planes. Discontinuous, thin (less than a metre thick) coal lenses occur rarely. Thin, massive andesite flows, which occur locally, may belong to the overlying Rocky Ridge Formation. The sedimentary succession generally strikes northwest and dips both to the northeast and southwest up to 50°. The variable dip orientation is attributed to emplacement of the diorite stock. There is no sulphide mineralization in the sedimentary rocks.

The porphyry copper target is a quartz-rich stock which intrudes the Kitsuns Creek sedimentary rocks. The stock, approximately 3 by 4 kilometres in size, is a fine to medium-grained, very light to patchy dark grey, porphyritic rock. A quartz-feldspar matrix supports 15 to 40% subhedral, medium-grained plagioclase phenocrysts. Mafic phenocrysts are rare. The stock is tentatively identified as a Bulkley diorite to granodiorite intrusion, with secondary silicification and phyllic alteration that gives it a more felsic appearance. Alternatively, MacIntyre et al. (1995) correlate the intrusion with the more felsic Nanika intrusions, and this is the interpretation shown on Figure 2. If correct, the quartz content of the Zymo stock may be a primary constituent rather than an alteration product. The porphyritic texture of the diorite is commonly diffuse to highly obscured by an overprint of moderate to pervasive phyllic alteration (quartz-sericite-pyrite) and silicification. This makes rock classification difficult by giving the dioritic rock an almost dacitic appearance. Although not seen on surface, drill core exhibits local complex alteration with a very fine grained, buff-coloured sericite-albite-clay(?) alteration that is intermixed with pale green sericite-chlorite(?) alteration. Rock geochemical data is presented in Table 2.

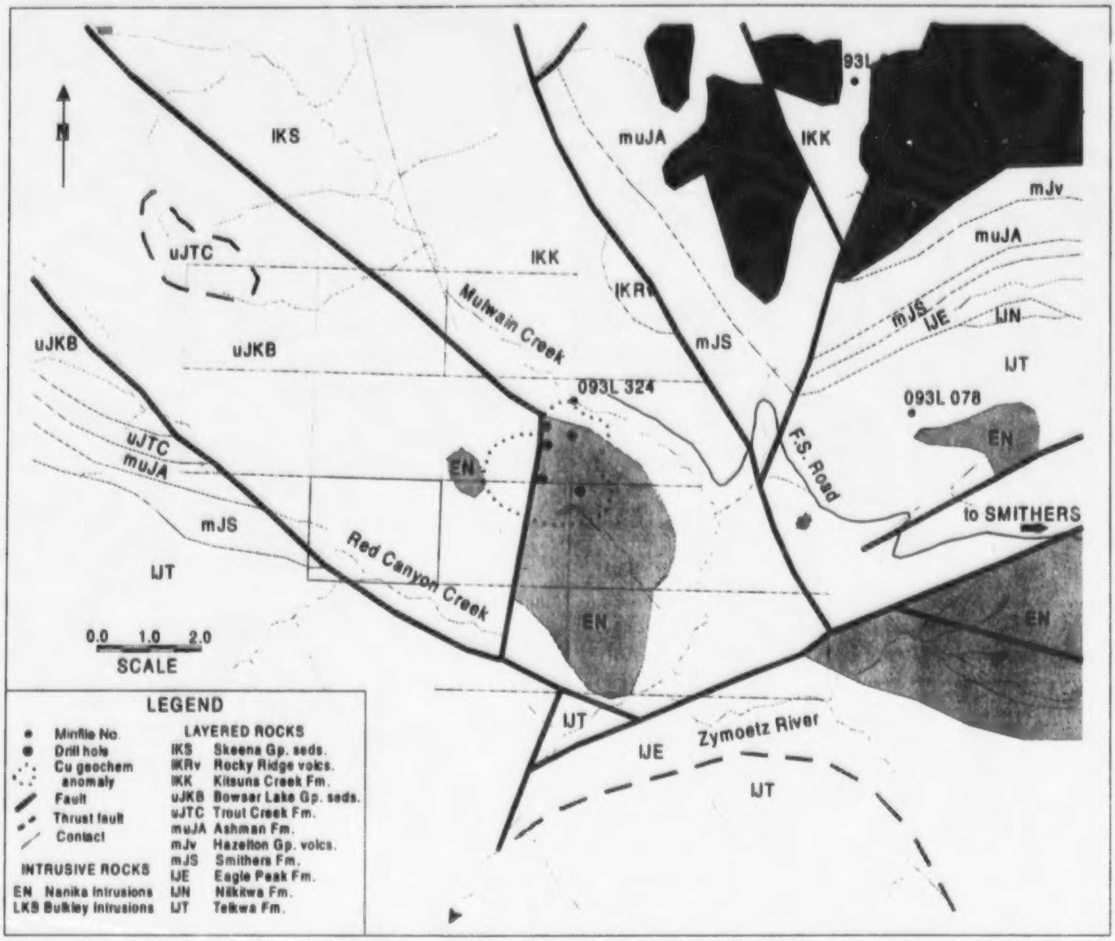
Rarely observed in outcrop, substantial intersections of breccia are noted in drill core. Two types of breccia have been seen: a heterolithic 'collapse' breccia, 75 metres thick, overlies the diorite in one drill hole, and an intrusive breccia occurs as separate 'pipes', 20 to 30 metres thick within massive diorite. Late-stage diabase and andesite porphyry dikes occur locally. Numerous, generally steeply dipping, faults were noted in drill core and are characterized by clay fault gouge, 0.20 to 1.50 metres wide, with rounded rock fragments.

Veining is present throughout the stock and consists of quartz, quartz-carbonate and anhydrite. Quartz and quartz-carbonate occur mainly as thin (1-10 mm), steeply dipping veinlets and stringers which usually exhibit moderate to well developed selvages of silica as quartz flooding and wallrock alteration. Less common, late-stage milky white to translucent purple anhydrite and/or gypsum occur as veins 10 millimetres to more than 1 metre wide. They have a moderate to shallow dip and crosscut quartz stringers. Closely spaced stockwork style veining was not seen in outcrop or in drill core.

Sulphide mineralization in the quartz diorite is predominantly pyrite, occurring pervasively as part of the phyllic alteration assemblage. It is fine grained and disseminated and also occurs on fracture planes and in quartz and anhydrite veins. Pyrite is also observed as alteration rims of rare xenoliths. Although pyrite averages 1 to 4% overall, up to 10% pyrite occurs over widths up to 75 metres. Where creeks have eroded into pyrite-rich zones, extensive gossan has developed on surface. Chalcopyrite, bornite, galena and sphalerite+/-magnetite occurs predominantly within quartz, quartz carbonate and anhydrite veins. Chalcopyrite+/-bornite+/-galena+/-sphalerite veinlets are rare and widely spaced. Very fine grained, disseminated chalcopyrite+/-bornite occurs very rarely over intervals of less than a metre to 2 metres within the quartz diorite. Very fine grained chalcopyrite also occurs as inclusions within pyrite. Overall percentages are trace to less than 1%.

CONCLUSIONS

The Zymo property is underlain by a phyllic-altered, pyritic quartz diorite stock with local copper, zinc, lead, silver and gold mineralization and anomalous arsenic+/-antimony rock geochemistry. The alteration, mineralization and rock geochemistry are similar to the Louise Lake high-level porphyry prospect, 7 kilometres to the east, which has a calculated resource of 50 million tonnes grading 0.3% Cu and 0.3 g/t Au (Hanson and Klassen, 1995).


N
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uJKB
uJKB
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093L 324
093L 078
uJTC
muJA
EN
EN
F.S. Road
to SMITHERS
mJS
Red Canyon Creek
lJT
EN
EN
0.0 1.0 2.0
SCALE
lJT
lJE
Zymoetz River
lJT
LEGEND
Minfile No.
Drill hole
Cu geochem anomaly
Fault
Thrust fault
Contact
INTRUSIVE ROCKS
EN Nanika Intrusions
LKB Bulkley Intrusions
LAYERED ROCKS
lKS Skeena Gp. seds.
lKRv Rocky Ridge volcs.
lKK Kitsuns Creek Fm.
uJKB Bowser Lake Gp. seds.
uJTC Trout Creek Fm.
muJA Ashman Fm.
mJv Hazelton Gp. volcs.
mJS Smithers Fm.
lJE Eagle Peak Fm.
lJN Nilkitwa Fm.
lJT Telkwa Fm.

Figure 2. Location and geologic setting of the Zymo mineral property.

Although copper and gold results from the first drilling program were modest, the presence of extensive phyllic alteration with local copper-silver-gold mineralization is encouraging. The overlying glacial till would suggest that the geochemical soil anomalies are hydromorphic and have been transported over some distance thus increasing the area for a more widespread exploration program. Continued exploration of the Zymo property is recommended to search for a potassic-altered core of the intrusion which might contain higher grades of copper and gold.

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TABLE 2. ROCK GEOCHEMISTRY

(R denotes bedrock sample, F denotes float sample)

		Au (ppb)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	As (ppm)	Sb (ppm)
1	R-96-18	1470	48.5	0.12	0.60	11.0	499	21
2	F-96-14	6900	468.2	0.12	2.20	19.0	581	302
3	F-96-15	3167	<0.1	0.09	1.53	28.0	572	72
4	F-96-17	2950	117.2	0.03	0.89	5.70	591	51
5	F-96-22	1800	151.5	3.20	0.30	0.25	300	<5
6	F-96-23	2225	150.7	0.22	1.41	4.40	243	150
7	F-96-25	2030	143.5	0.36	0.51	2.30	241	36
8	F-96-26	2300	332.5	0.66	1.09	4.50	509	1992
9	F-96-27	3660	168.2	0.97	1.66	6.80	487	86
10	F-96-30	1310	131.8	0.22	1.68	12.0	698	80
11	F-96-32	935	166.0	0.30	1.67	19.0	277	76
12	F-96-36	1670	221.6	0.25	0.79	5.10	117	153
13	F-96-40	5670	308.4	1.90	0.45	3.90	8234	878
14	R-97-03	7233	>200.0	0.24	>1.00	>1.00	607	119
15	R-97-15	428	11.4	0.97	0.01	0.01	59	13
16	R-97-17	275	19.7	>1.00	0.003	0.01	41	21
17	F-97-02	1584	-	0.04	0.08	0.04	2011	46
18	F-97-30	1609	23.1	0.53	0.23	>1.00	916	89
19	F-98-13	587	11.4	0.02	0.16	0.07	4045	20
20	F-98-24	367	75.4	0.03	>1.00	>1.00	310	35
21	F-98-25	305	21.8	0.07	>1.00	>1.00	235	15

VOLCANOGENIC MASSIVE SULPHIDE POTENTIAL IN THE SLIDE MOUNTAIN AND BARKERVILLE TERRANES, CARIBOO MOUNTAINS

By Bob Lane and Ken MacDonald

INTRODUCTION

Exploration for volcanogenic massive sulphide (VMS) mineralization in the Cariboo Mountains, east of Highway 97, has been intermittent over at least the last four decades. Recent developments include the identification of three significant VMS float occurrences north of Wells, in an area underlain by rocks of the Slide Mountain Terrane and discovery of a VMS lens south of Cariboo Lake, in rocks of the Barkerville Subterrane. Both discoveries have important regional implications. A re-evaluation of prospective VMS belts including the Slide Mountain Terrane (Antler Formation) and Barkerville Terrane (Snowshoe Group) is warranted.

The Cariboo is best known for its rich placer gold fields in the Wells-Barkerville area, where approximately 2 million ounces of gold have been recovered since the initial discovery in 1858. Lode mining, principally of mesothermal vein and pyrite-replacement mineralization from the Cariboo Gold Quartz, Mosquito Creek and Island Mountain mines, produced an additional 1.8 million ounces of gold. These gold-rich lode deposits were associated primarily with Downey succession (Snowshoe Group) stratigraphy of the Barkerville Subterrane. There is no record of lode metal mining from deposits hosted by Antler Formation strata of the Slide Mountain Terrane.

A review of geological, geochemical and geophysical data relating to exploration for VMS deposits within the terranes east of Highway 97 was undertaken. Our research is not exhaustive and information presented here is intended to stimulate interest and increase exploration for volcanogenic massive sulphide deposits in these two very prospective geological belts.

REGIONAL GEOLOGY

The most recent regional mapping in the area was conducted by Panteleyev et al. (1996) and Struik (1983, 1988) who covered 1:50 000 scale mapsheets 93A/11, 13 and 14 and 93H/3 and 4 and built upon previous mapping by Campbell (1978), Campbell et al. (1973) and Sutherland Brown (1957, 1963).

The Cariboo region (Figure 1) is underlain by four fault-bounded geological terranes, or subterranes: Quesnel, Barkerville, Slide Mountain and Cariboo. Furthest east is the Cariboo Subterrane (a subset of the Cassiar Terrane), a displaced segment of the North American continental margin. It consists of Precambrian to Permo Triassic clastic and lesser carbonate rocks. The Barkerville Subterrane is part of the pericratonic Kootentay Terrane that was probably deposited along the western margin of ancestral North America. It is dominated by Precambrian and Paleozoic grit, quartzite, pelite and lesser limestone and volcaniclastic rocks. The westerly directed Pleasant Valley thrust separates the Cariboo and Barkerville subterranes.

The structurally imbricated, oceanic Slide Mountain Terrane was faulted into position on the western margin of the Barkerville Subterrane along the Eureka thrust. North of Wells, it overlies the Cariboo and Barkerville subterranes on the Pundata thrust and primarily comprises Mississippian to Permian basalt and chert-pelite sequences that are cut by diorite, gabbro and lesser ultramafic intrusions (Struik, 1988). Greywacke, grit conglomerate and serpentinite are minor components. Sinuous bands of sheared and metamorphosed rock, assigned to Slide Mountain Terrane (Crooked Amphibolite), are exposed discontinuously along the west-verging Eureka thrust fault. The Quesnel Terrane structurally overlies Barkerville and Slide Mountain rocks along the Eureka fault. It is mainly an island arc assemblage consisting of basal Upper Triassic black clastic rocks followed by basic to intermediate volcanics.

BARKERVILLE SUBTERRANE

Rocks of the Barkerville Subterrane have been assigned largely to the Late Proterozoic to mid-Paleozoic Snowshoe Group (Struik, 1983, 1988). They consist mainly of fine-grained siliciclastic and pelitic metasediments with lesser carbonate and volcanic rocks (Struik, 1988). The Snowshoe Group has 14 informal subdivisions, several of which contain a significant mafic±felsic volcanic component. Volcanic rocks are chlorite schists, meta tuffs, felsic lapilli tuffites,

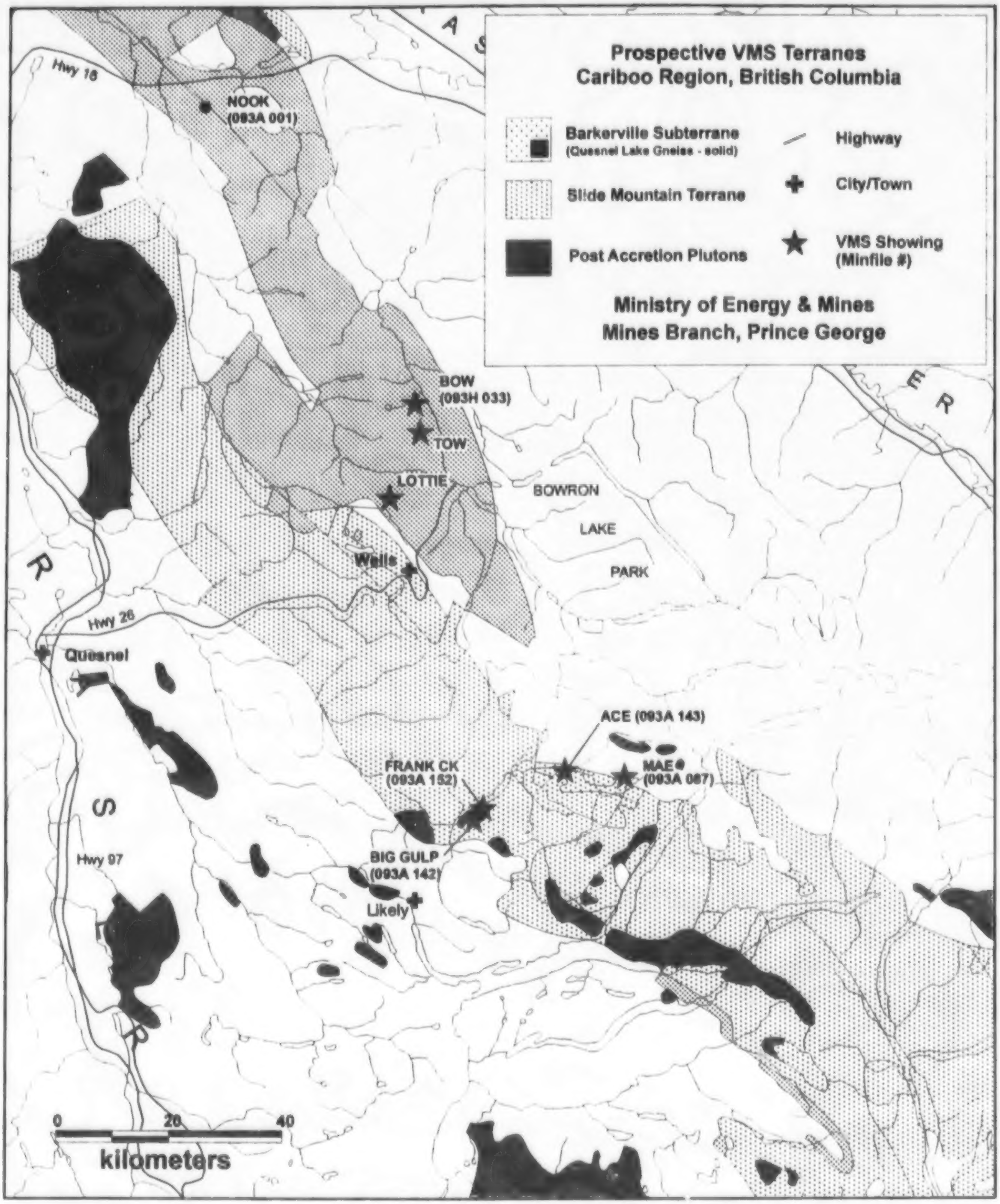
Prospective VMS Terranes
Cariboo Region, British Columbia
Barkerville Subterrane
(Quesnel Lake Gneiss - solid)
Highway
Slide Mountain Terrane
City/Town
Post Accretion Plutons
VMS Showing (Minfile #)
Ministry of Energy & Mines
Mines Branch, Prince George
Hwy 16
NOOK (093A 001)
BOW (093H 033)
TOW
LOTTIE
Wells
BOWRON
LAKE
PARK
Hwy 26
Quesnel
ACE (093A 143)
MAE (093A 087)
FRANK CK (093A 152)
BIG GULP (093A 142)
Likely
Hwy 97
0
20
40
kilometers

Figure 1. Distribution of Barkerville Subterrane and Slide Mountain Terrane and volcanogenic massive sulphide prospects in the Cariboo Mountains region of central British Columbia.

amphibolites and rare, pillowed basalts. Intense deformation and moderate to high grades of regional metamorphism make interpretation of Snowshoe Group rocks difficult (Struik, 1988; Höy and Ferri, 1998).

Snowshoe rocks resemble, in part, the Paleozoic Eagle Bay assemblage of the Adams Plateau - Clearwater area (Schiarizza and Preto, 1987). They have also been correlated with the Lower Paleozoic Lardeau Group and the Carboniferous Milford Group of the Kootenay Arc (Struik, 1986). In the Selkirk Mountains of southeastern British Columbia, phyllites and quartzite of the Lardeau Group host the Goldstream stratabound copper-zinc deposit (Höy et al., 1984). Goldstream, and the VMS prospects described below that are hosted by lithologies similar to Snowshoe Group, have characteristics of Besshi-type bedded cupriferous iron sulphide deposits.

The Quesnel Lake gneiss (QLG) intrudes the western margin of the Barkerville Subterrane. Individual intrusive bodies are elongate and generally oriented along the tectonic boundary between the Barkerville and Slide Mountain terranes. Ferri et al. (1999) subdivided QLG into a western group, characterized by K-feldspar megacrysts, and an eastern group, that is more equigranular and homogeneous. Uranium-lead dating confirmed that the age of these calcalkaline granitic orthogneisses is 357.2 ± 1.0 Ma or early Mississippian (Ferri et al., 1999). They may be related to little recognized felsic volcaniclastics within Snowshoe Group stratigraphy (Höy and Ferri, 1998; Ferri et al., 1999).

VMS EXPLORATION IN SNOWSHOE GROUP

Exploration for VMS deposits in Snowshoe Group rocks of the Cariboo Mountains has been sporadic since the discovery of massive sulphide float south of Cariboo Lake in 1983. However, placer miners commonly unearthed semimassive to massive sulphide boulders when processing gold-bearing gravels near the mouth of Frank Creek (Guinet, 1988). In 1983, Silver Standard Mines Ltd. completed a soil sampling and limited trenching program over a 2000 by 1200 metre area on what was then the Thunder property. It encompassed an area mainly west of Frank Creek, where prospectors had discovered pyrite-chalcopyrite mineralization in float and suboutcrop (Beaton, 1983). Three copper±zinc±silver anomalies were trenched with disappointing results, although one trench below a switchback in the 'D' road cut through several metres of ferricrete. The transported gossan contains clasts of semimassive to massive pyrite±chalcopyrite similar to material located in a nearby road side ditch.

In 1988, Formosa Resources Corporation completed grid-based bedrock mapping, soil geochemical, and magnetic and VLF-EM surveys over much of the same area, known then as the Mass property (Martin, 1989). In 1991, Rio Algom Exploration Inc. completed an airborne magnetic, EM and radiometric survey over the Mass claims and identified a number of anomalies, but none were pursued (McClintock, 1991). In 1996, R. Yorston drilled two vertical percussion holes, one to the northeast and the other to the southwest of the Silver Standard trench, to test the previously identified coincident geochemical-geophysical anomaly. Drill cuttings, sampled at 3-metre intervals, were anomalous to a depth of 21.3 metres in hole M96-1 and to a depth of 18.3 metres in hole M96-2, with individual highs of 1766 ppm Cu, 2970 ppm Zn, 750 ppm Pb, 4.8 ppm Ag and 790 ppb Au (Yorston, 1997).

Further east, prospecting in 1994 by Louis Doyle, along the north-facing slopes of Mount Barker, resulted in the discovery of semimassive sulphide and gold-quartz vein float (Lammle, 1995). Barker Minerals Ltd. staked the Ace property to cover the anomalous float and has since completed additional prospecting, geochemistry, geophysical surveys, bedrock mapping, trenching and drilling. The company also expanded its mineral tenure to include the previously discussed areas. Follow-up of past work in the Frank Creek area led to two new VMS prospects, the Big Gulp discovered in 1996 and Frank Creek, approximately 2.5 kilometres east of Big Gulp, discovered in 1999. A detailed description of the Frank Creek prospect is presented below. Brief descriptions of the Mae, Ace and Big Gulp prospects are also provided; for more detailed descriptions refer to Höy and Ferri (1998).

Mae prospect; MINFILE 093A 087

The Mae showing is comprised of layers of stratabound lead-zinc-copper mineralization and is characterized as a Besshi massive sulphide deposit. Located just west of Maeford Lake, the property was staked in 1988, based on the discovery of sulphide-bearing float. The showing is reported to be 500 metres south of the trace of the Pleasant Valley fault, which separates Late Proterozoic Snowshoe Group rocks of the Barkerville Subterrane from Hadrynian to Cambrian rocks of the Cariboo Subterrane to the north. In 1991, Cominco Ltd. conducted a modest program of rock and soil geochemistry and identified >100 ppm Pb and >500 ppm Zn soil anomaly measuring roughly 1.5 by 0.2 kilometres. Lithogeochemical sampling indicated that mineralization is carbonate hosted at the conformable contact between Downey succession calcsilicate/ amphibolite and overlying Bralco succession marble. Subsequent soil surveys outlined three broad coincident lead-zinc anomalies. Weakly mineralized float from zone B contains 238 ppm Cu, 11 354 ppm Pb, 5570 ppm Zn and 17.6 ppm Ag. The mafic volcanic and metasedimentary host succession lends credence to the VMS classification, but the showing also shares similarities with stratabound lead-zinc showings.

Ace prospect; MINFILE 093A 143

The Ace property is located south of the Little River, 35 kilometres northeast of Likely. Two styles of mineralization, stratabound semimassive sulphides and auriferous quartz-sulphide veins, have been recognized (Lammle, 1995; Höy and Ferri, 1998). The two styles were both originally recognized in float, and subsequent work by Barker Minerals has revealed both styles insitu. Mineralization occurs in quartz-feldspar schists and minor quartzites of the Downey succession. The semimassive sulphide variety is comprised dominantly of pyrrhotite, minor chalcopyrite and pyrite±sphalerite with associated coincident Zn and Pb geochemical soil anomalies. The metal content, siliceous alteration and hostrock lithology suggest an affinity to Besshi-style VMS deposits.

Numerous white quartz veins, locally with abundant pyrrhotite-pyrite±arsenopyrite±chalcopyrite±galena and commonly ankerite and tourmaline, comprise the other style of mineralization found on the property. Veins exposed in trenches and intersected in drilling generally are anomalous in Au, Ag, Cu, As, Zn, Pb, Se, Te and Bi (Payne, 1998). Local bismuth soil anomalies, and spot highs in gold, are believed to be indicative of buried vein mineralization. The hostrock lithology and metal content suggest affinity to well-explored gold-quartz veins of the Yanks Peak and Cow Mountain areas to the north. The geologic setting, style of mineralization and geochemistry suggest an analogy to the "plutonic-associated" or "Pogo-type" gold vein model.

Big Gulp prospect; MINFILE 093A 142

The Big Gulp showing is located near the western edge of a large claim group that borders the south shore of Cariboo Lake, about 20 kilometers northeast of Likely. It was discovered by Barker Minerals Ltd. in 1996. Work done in 1998 was limited to reconnaissance mapping, some sampling and a soil geochemical survey. Mapping by the Geological Survey Branch indicates the showing is underlain by Downey succession phyllites which are interpreted to be altered mafic tuffs. The phyllites are themselves underlain by Paleozoic Quesnel Lake gneiss and "structurally overlain by a 'chert to cherty tuff' horizon and then argillite" (Höy and Ferri, 1998). Mineralization comprises thin layers of dark sphalerite, minor chalcopyrite and pyrite. Sulphides were also noted in thin quartz stringers parallel to foliation. Assays of grab samples ranged up to 4.5% Zn and 0.06% Cu (Höy and Ferri, 1998). The mafic volcanic host succession, strong sericitic alteration and metal content identify this showing as Besshi-type.

Frank Creek prospect; MINFILE 093A 152

The Frank Creek volcanogenic massive sulphide prospect was discovered by Barker Minerals Ltd. in October, 1999. It is located immediately west of Frank Creek (formerly Goose Creek), 2 kilometres south of Cariboo Lake and approximately 20 kilometres by road from Likely. Access to the prospect is via the 'D' road, a spur of the main Weldwood 8400 logging road. The discovery was made by trenching an area of polymetallic massive sulphide float on the uphill side of a switchback on the 'D' road, 2.5 kilometres from the 8400 road turnoff.

The Frank Creek property is underlain by a sequence of grits, quartzite, phyllite, schist, marble and undifferentiated metasedimentary rocks, assigned to the Paleozoic Harveys Ridge succession (Snowshoe Group), that is intruded by Quesnel Lake orthogneiss (Struik, 1983, 1988). Detailed property-scale mapping identified an abundance of tuffaceous mafic volcanic rocks (Martin, 1989), and more recently, pillow basalts (Payne, 1999), stratigraphy that is more characteristic of the Downey succession. Remapping of an area near the discovery trench resulted in reinterpretation of some of the coarser grained rocks as reworked felsic lapilli tuffs (Payne, 1999). Most lithologies are strongly foliated, phyllitic or schistose, making it difficult to distinguish bedding attitudes and fine-grained sedimentary rocks from volcanic rocks.

In 1999 prospecting by Barker Minerals focused on the 'D' road switchback area where previous work overlapped and several mineralized float and/or suboutcrop showings were known. Thorough prospecting led to the discovery of a number of intensely oxidized massive sulphide cobbles. A composite sample comprised of several cobbles assayed 2.02% Cu, 305 ppb Au, 1.16% Pb and 0.94% Zn. A single follow-up trench exposed a massive sulphide lens in excess of 1.2 metres thick (Photo 1). It is composed mainly of fine-grained pyrite with local disseminations and whispy bands of chalcopyrite, pale brown sphalerite and galena. It is unlikely that these delicate textures are primary; they probably formed as a result of recrystallization during regional metamorphism.

Fractures and a foliation-parallel fabric contain coarser grained base metal sulphides with silica±chlorite. Structural measurements are variable, but the stratabound massive sulphide lens has a northeasterly strike and a gentle to moderate northwesterly dip. Several narrow, steep north-trending clay-gouge-filled fractures cut the massive sulphide and may be planes along which minor

1.2 metres
massive
sulphide
lens

Photo 1. Frank Creek discovery trench.

movement has occurred. Hostrocks are dark grey to black phyllites and, together with the overlying felsic rocks, are pervasively iron-carbonate altered and commonly contain euhedral pyrite porphyroblasts. In the area of mineralization, foliation of the host phyllites has a northwesterly trend and is consistently steeper than bedding, indicating that stratigraphy is not overturned.

A 1.2-metre channel sample of the massive sulphide lens, taken approximately perpendicular to bedding, assayed 0.65% Cu, 0.14 g/t Au, 69 g/t Ag, 0.12% Pb and 0.10% Zn. In addition to the main lens, numerous small lenses of massive pyrite-chalcopyrite±sphalerite±galena, up to 10 centimetres thick, were noted (Photo 2).

Photo 2. Close-up of small massive pyrite-chalcopyrite lens (outlined) within phyllites of the Downey succession, Frank Creek discovery trench.

The potential for additional discoveries of massive sulphide lenses on the property is considered to be high. Many coincident multi-element geochemical and geophysical anomalies have yet to be tested, and with the exception of two short, vertical percussion holes, no exploration drilling has been done in the area.

SLIDE MOUNTAIN TERRANE

In the Cariboo Mountains, north of the Pundata thrust fault, stratigraphy of the internally imbricated Slide Mountain Terrane is assigned to the Mississippian-Permian Antler Formation (Struik, 1988). The Antler Formation consists mainly of intermediate to mafic pillowed, flow and pyroclastic volcanic rocks, chert, and black shale. The Crooked amphibolite, the sheared and metamorphosed equivalent of the Antler Formation (Struik, 1987), forms a thin discontinuous map unit along the eastern margin of Quesnellia and, although part of the Slide Mountain Terrane, is not included in this discussion.

Sequences correlative with the Antler Formation extend beyond the length of the British Columbia portion of the Cordillera. In northernmost British Columbia they are the Sylvestor Group, in the north-central part of the province the Nina Creek Group and in southern British Columbia the Fennell Formation and Kaslo Group.

Perhaps the most well known VMS deposit hosted by rocks assigned to the Slide Mountain Terrane is Chu Chua, in the Fennel Formation northeast of Kamloops.

Chu Chua, a Cyprus-type VMS deposit, consists of several stratiform, massive cupiferous pyrite lenses and associated massive talc, magnetite-talc and siliceous alteration zones within basalts of the upper Fennel Formation (Aggarwal and Nesbitt, 1984). Its drill-indicated resource totals approximately 2 million tonnes averaging 2% Cu, 0.4% Zn, 0.1% Co, 0.4 g/t Au and 8 g/t Ag (McMillan, 1980).

VMS EXPLORATION IN THE ANTLER FORMATION

There are only a handful of VMS occurrences in the Cariboo Mountains that are underlain by rocks of the Antler Formation. Many recent discoveries are concentrations of massive sulphide float over limited areas north of Wells. A review of Ministry of Energy and Mines assessment report files provides some background on the limited amount of work that has been conducted in the area and emphasizes the potential of the belt.

Volcanogenic massive sulphide occurrences within the Antler Formation are not well documented. Noranda Exploration Company, Ltd., Shell Canada Resources Ltd., Esso Minerals Ltd., BP Resources Canada Ltd. and several individuals conducted modest exploration programs in the region, in part, because of the 1977 discovery of the Chu Chua deposit to the south and later because of the 1986 release of regional geochemical stream sediment (RGS) data for the McBride map sheet.

North of Towkuh Creek and east of Bowron River, Esso Minerals and Noranda, respectively, outlined arsenic soil anomalies that were coincident with spot gold anomalies in soil and/or outcrop (Melnyk, 1982; Savell, 1989). Little follow-up work was done in both cases. Reconnaissance soil sampling by BP Minerals on the Slide 14 group of mineral claims south of Slender Lake - Eighteenmile Creek suggested that the underlying bedrock contained significant concentrations of barite (Farmer, 1986). A BP diamond-drill hole, referred to by Hoffman (1991), but not reported in the publicly available assessment report files, intersected 24 metres of 'low grade VMS style mineralization' averaging 253 ppm Cu, 912 Zn and 3.8 ppm Ag. The collar location for this hole is unknown, but the intersection came from the contact between quartz-feldpsar porphyritic rhyolite and argillite, a contact that was traced from west to east across the Slide 14 claim group. Glacial fabrics in the area suggested that the up-ice direction is to the southwest (Hoffman, 1991).

Noranda staked a series of large claim blocks in 1969, on the north side of Taspai Creek, after high copper values were obtained from a reconnaissance stream sediment survey. Over a period of three years, soil geochemistry, induced polarization, resistivity and VLF surveys were conducted on the Loon and Fu-Hu groups and outlined coincident copper and zinc anomalies. The area was re-staked in 1979 by Comaplex Resources International Ltd. and Vestor Explorations Ltd. as the Nook claims and additional ground magnetics and EM survey work was completed. Diamond drilling was recommended to test three conductor patterns, but the work was never undertaken. Later, Campbell Resources Ltd. took an option on the Nook property, and completed an airborne survey which outlined a linear belt of conductors south of a zone interpreted to be basic volcanic rocks. Campbell also completed a limited drilling program, with the best intersection reported to be 1.0 metre of 0.86% Cu and 0.1% Zn.

A second airborne EM/magnetic survey was conducted in 1982 over the central portion of the claim block and outlined two areas recommended for further work. A ground EM survey in 1983 further delimited the airborne conductors which are close to copper and zinc soil geochemical anomalies. Based on the recommendations from the earlier work, Comaplex/Vestor completed a four-hole drilling program in 1984, but failed to intersect any significant sulphide mineralization and was unable to explain the geochemical anomalies.

Shell Canada staked the Vama claims in 1978 to cover a number of anomalies outlined by the same airborne geophysical survey that CCH Resources Ltd. had flown in the Bowron River area (including Purden Lake and Taspai Creek). The Vama claims were located 38 kilometres east of Prince George, immediately south of Highway 16E and north of the Nook property. Shell established five grids and completed soil geochemistry, mapping, EM, magnetic and VLF-EM surveys. The work outlined several anomalies in favourable rock types that were recommended for drilling. Reconnaissance and detailed mapping by Gary Johnston in 1994 and 1995 resulted in the staking of the Pegasus claims over the old Vama claims. Recent work has focused again on establishing coincident soil and geophysical anomalies, and at least three strong self potential anomalies have been delineated.

A program of mapping and ground EM surveys was completed in 1983 on the Slide 1-5 claims by BP Exploration Canada Ltd. The claims were located along Highway 16, approximately 30 kilometres east of Prince George and immediately west of the location where the Nook claims had once been established. At least six conductors were located on ground believed to be underlain by Slide Mountain Group volcanics. Induced polarization surveys over the conductors followed by drilling coincident anomalies was recommended, but there is no record of this work ever being done.

The most recent work in Slide Mountain Terrane consists of prospecting, airborne and ground-based geophysical surveys, soil and till geochemistry and limited test-pitting. Several new anomalies have been discovered. A review of these is presented below.

Bow float prospect; MINFILE 093H 033

The Bow VMS prospect, discovered and staked by Martin Peter in 1996, consists of a concentration of massive sulphide float that covers an area measuring 300 by 150 metres. The property is located about 30 kilometres north of Wells and is underlain by intermediate to mafic volcanic flows and tuffs and chert of the Antler Formation.

Float samples of thinly bedded massive pyrite-chalcopyrite assayed up to 3.1% Cu and 0.25 g/t Au (M. Peter, personal communication, 1998). A second float concentration (Tow), located approximately 5 kilometres to the south, just north of Towkuh Creek, was identified later in 1996. The Tow float is on part of a geochemical grid established in 1981 by Esso Minerals. Semimassive sulphide float, found over a limited area, assayed up to 6.96% Cu and 4.72 g/t Au (M. Peter, personal communication). Bedrock is exposed over less than 5% of the area and the source of the mineralized float has not been identified. Eureka Resources Inc. optioned the Bow 1 property in 1997 and staked additional claims to cover the Tow anomaly. In 1998, the company conducted an airborne magnetic and electromagnetic survey over the claims. Follow-up grid-based ground truthing confirmed the presence of numerous conductors that remain untested by drilling or trenching (Kerr, 1998).

Lottie float prospect; NO MINFILE

The Lottie VMS float prospect (Photo 3), 15 kilometres north of Wells, was discovered and staked in July, 1998, by prospector Martin Peter. The property is readily accessible by the Ketchum (2400) logging road that leaves Highway 26 approximately 20 kilometres west of Wells. The float, discovered in a roadside ditch in a clear-cut less than 1 kilometre west-southwest of Lottie Lake, consists of a small angular block of chalcopyrite-rich massive sulphide and several larger, angular boulders of mineralized chert and/or silicified intermediate volcanic rock (Photo 4). A sample of massive chalcopyrite assayed 24.3% Cu, 400 ppb Au and 19.6 ppm Ag and samples of mineralized chert ran up to 1.77% Cu (M. Peter, personal communication). The property was optioned to Eureka Resources Inc. later that year.

Photo 3. Lottie VMS float discovery and area of test pitting in ditch and road cut less than one kilometre southwest of Lottie Lake. Pictured from left to right are Jack O'Neill (Eureka Resources), Roger Paulin (consultant), John Kerr (Eureka Resources) and Peter Bobrowsky (BC Geological Survey Branch).

The claim is underlain mainly by cherty argillite and basalt of the Antler Formation. Felsic volcanic flows (dacite?) occur in suboutcrop upslope from the discovery. Immediately west of the discovery, near a small, seasonal placer gold operation, hornblende diorite, gabbro, chert and mafic tuffs are intruded by a small feldspar-porphyritic plug.

Photo 4. Sulphide-bearing siliceous argillite (exhalite?) float from test pit, Lottie property.

In 1999, the company conducted a modest program that included soil and till geochemical sampling, a VLF electromagnetic survey, a glacial till fabric study and test pitting. Test pitting of the high-grade float area did not locate its bedrock source, but did uncover many more angular blocks of massive sulphide mineralization that ranged from 1% to 21% Cu, with anomalous gold grades. A grab sample of pyrite-rich massive sulphide assayed 1.03% Cu, 240 ppb Au and 0.06% Co.

In late November, after staking additional claims to link the Lottie and Bow properties, Eureka optioned the contiguous tenure package to Hudson Bay Mining and Smelting, an affiliate of Anglo American Plc. Hudson Bay plans to conduct airborne and ground-based geophysical surveys, geochemistry, geological mapping and diamond drilling on the property in 2000.

Nook; MINFILE 093G 001

The Nook showing is located near Mount Bowron, on the north side of Taspai Creek. It is underlain by cyclic volcanic-sedimentary sequences of the Upper Mississippian Slide Mountain Group. The group consists of basalts, breccia, tuff, chert, argillite, sandstone, limestone and conglomerate. The units strike north to northwest and dip moderately to steeply west. One drill intercept (N-80-6) tested a massive sulphide zone about 1 metre wide at the contact between black graphitic argillite and a quartz feldspar porphyritic dacite and returned anomalous copper and zinc values. Four subsequent holes did not intersect economic mineralization. Most holes cut arkose, siltstone, argillite and limestone underlain by porphyritic dacite. The dacite is silicified and chloritized, and pyrite is disseminated throughout much of the rock. Malachite staining is present on outcrops. In 1969, a grab sample assayed 0.08% Cu, 0.25% Zn, 0.22% Pb and 0.001% Mo with trace gold and silver.

EXPLORATION GUIDES

COMPANY EXPLORATION DATA

There are relatively few published reports of systematic VMS prospecting in the region. A preliminary review of nearly 400 assessment reports filed over the past thirty years identified only 35 that describe exploration for VMS or related mineral deposits. The work represents claim assessment on roughly 14 properties, several of which are now reconfigured as larger claim blocks covering known VMS occurrences. However, within the total are several areas that are now either unclaimed or adjacent to recent staking. There is good evidence to suggest that these areas warrant re-evaluation. Data from selected company assessment reports have been summarized and are presented below in Table 1.

REGIONAL GEOCHEMICAL SURVEY DATA

The Regional Geochemical Survey (RGS) database is a powerful exploration guide and provides complete coverage of the Cariboo Mountains region. However, data for mapsheets 93G and 93H are limited to a relatively small suite of trace elements such as copper, zinc and cobalt. Recently, archived samples from mapsheet 93A were re-analysed and new data for gold, arsenic, antimony, rare earths and other elements are available (Jackaman, 1999). The re-analysis of archived samples from mapsheets 93G and 93H has not yet been scheduled--a more comprehensive suite of pathfinder elements would greatly increase the usefulness of the existing data. Immobile element anomalies in soil and till, such as gold and mercury, can be the most direct indicators to the location of concealed base metal sulphides (Lett et al., 1998).

Caution must be exercised when interpreting values reported from stream sediment samples due to the complexity of the stratigraphic record, variation in overburden thickness, ice direction and episodic glaciation. With the support of bedrock mapping,

TABLE 1. EXPLORATION DATA COMPILED FROM SELECTED COMPANY ASSESSMENT REPORTS, MINFILE AND GEOLOGICAL SURVEY BRANCH REPORTS (PARTS OF 93A, 93G, & 93H)

Ass. Rpt. #	NTS	Year	Property	Operator	Commodities	Geochem Soils (#)	Silts (#)	Rock (#)	Geophy Mag/Em	R/IP/ SP	Drilling (#/m)	Trench (#/m)
23733	093A14E	1995	Ace	Doyle, Louis	AG, AU, PB, ZN	1209			33.3			
24286	093A14E	1996	Ace	Barker Min. Ltd.	AU, AG, ZN, CU, PB	1880			110			
24988	093A14E	1997	Ace	Barker Min. Ltd.	AU, AG, CU, ZN, PB							
24989	093A14W	1997	Ace	Barker Min. Ltd.	AU, AG, CU, ZN, PB	1256		267	147	53.6		36/3700
25437	093A14E	1998	Ace	Barker Min. Ltd.	AU, AG, CU, ZN, PB	336	331	584	11.9			20/835
25752	093A11W	1998	Big Gulp	Barker Min. Ltd.	AU, AG, CU, ZN, PB		6	3				
11620	093A11W	1983	Thunder	Silver Standard Ltd.	AU, AG, CU, ZN, PB	419	2	3				3/50
17696	093A14W	1988	Mass	Guinet, Victor	AG, AU, PB, ZN		22					
19345	093A11W	1989	Mass	Formosa Res. Corp.	AG, CU, PB, ZN	1416		66	30.3			
21930	093A11W	1991	Mass - Annex	Rio Algom Expl. Inc.	AG, CU, PB, ZN	21	56	5	388			
22599	093A11W	1992	Mass	Rio Algom Expl. Inc.	PB, ZN	308	35	87	17.3			6/390
22642	093A11W	1992	CCH	Rio Algom Expl. Inc.	PB, ZN	120	4	9				
24662	093A11W	1996	Mass	Yorston, Robert	CU, PB, ZN, AG, AU			19			2/60.9	
25133	093H05E	1997	Bow	Peter, Martin	CU, ZN, AU, AG	93	33	12	22			
25746	093H05E	1998	Bow	Eureka Res. Inc.	CU, AU, ZN, AG	837			36.5 377 air			
10731	093H05E	1982	Antler	Esso Res. Can. Ltd.	CU, ZN, AU, AG	284		27				
16121	093H06W	1987	Bowron River	Noranda Expl. Ltd	CU, ZN, AU, AG	310			328 airborne			
17754	093H06W	1988	Bowron River	Noranda Expl. Ltd.	CU, ZN, AU, AG	233	12/90	1				
19091	093H06W	1989	Bowron River	Noranda Expl. Ltd.	CU, ZN, AU, AG	473						
12234	093G16E	1983	Slide	BP Expl. Can. Ltd.	CU, ZN, AU, AG				8.7			
14588	093H05W	1985	Slide	BP Min. Ltd.	CU, ZN, AU, AG	402		82	63			12/390
14589	093H05E	1985	Slide	BP Min. Ltd.	CU, ZN, AU, AG							
21613	093H05E	1991	DH	De La Mothe, D	AG, CU, ZN	358						
22562	093H05E	1992	DH	De La Mothe, D	AG, CU, PB, ZN							
19327	093A14E	1989	Mae	Cominco Ltd.	PB, ZN	1020						
21886	093A14E	1991	Mae	Cominco Ltd.	PB, ZN	272						
24418	093G16E	1996	Pegasus	Johnston, Gary	ZN, CU, AG	148		1	5.4	3.4		
25528	093G16E	1998	Pegasus	Johnston, Gary	ZN, CU, AG	305			10	10.5		
01633	093G16E	1968	Loon	Noranda Expl. Ltd.	ZN, CU, AG	60						
01952	093G16E	1969	Loon	Noranda Expl. Ltd	ZN, CU, AG	160				35		
02615	093G16E	1970	Willow	Noranda Expl. Ltd.	ZN, CU, AG	167			18	11		1/60
07320	093G16E	1979	Vama	Shell Canada	ZN, CU, AG	1811			93.8			
08015	093G16E	1979	Nook	Vestor Ex.	ZN, CU, AG				13.2			
08160	093G16E	1980	Nook	CCH Res.	ZN, CU, AG				778 airborne			
10706	093G16E	1982	Nook	Comaplex Res. Intl.	ZN, CU, AG				58.6 airborne			
11573	093G16E	1983	Nook	Comaplex Res. Intl.	ZN, CU, AG				9.1			
13136	093G16E	1984	Nook	Comaplex Res. Intl.	ZN, CU, AG						4/319	

MINFILE and assessment reports, the RGS data can identify prospective areas for follow-up exploration. Massive sulphide deposits are relatively small in areal extent and can be difficult to locate in areas of extensive drift cover, such as the valleys and plateaus of the region. Interpretation of stream sediment anomalies is complicated by glacial and fluvial events that have acted to disperse relatively mobile elements. Key to the interpretation of the data is a sound knowledge of the surficial geology of the region, and an understanding of the history of glaciation, particularly direction of ice advancement.

RGS data for the Cariboo Mountains area is presented in Figure 2. A brief discussion of several prospective areas is presented here to highlight the potential of the existing data. Numerous stream sediment sites in the region were found to have anomalous geochemical signatures not associated with known mineral occurrences. If one calculates percentiles for various elements from RGS samples taken only in Slide Mountain and Barkerville terrane rocks that fall within the region (584 samples), anomalous patterns are produced which may represent the presence of buried VMS mineralization. For instance, 59 of 584, or 10% of the samples returned zinc values in excess of the 90th percentile, of which 30 (5.1%) were in excess of the 95th percentile. Nearly two-thirds of these are located in Barkerville Subterrane rocks. Similarly, 58 of 584 or 10% of the samples returned copper values in excess of the 90th percentile, of which 29 (5.0%) were in excess of the 95th percentile. Looking at samples that returned both copper and zinc values greater than their respective 95th percentile, a total of eight samples were detected. Of these, again nearly two-thirds were found in Barkerville Subterrane rocks. Element-sum ranking, a method described by Cook and Pass (2000), enables one to evaluate a suite of elements that are characteristic of VMS deposits. Thirty samples, or 5% of the sample population, were found to have an element-sum ranking consistent with VMS deposits.

A relatively well-developed copper-zinc anomaly has been detected by stream sediment sampling northwest of Spring Mtn. (93G/16). Three samples (841511 - 841513) exhibit elevated copper contents that are within the upper five percentiles of data for copper and one sample exceeds the 90th percentile for zinc. RGS stream sediment geochemical data from the upper reaches of Tsus Creek (93H/12) are elevated in copper and zinc. Three samples (841217 -841219) are within the upper five percentiles of data for copper, but more subdued for zinc, being greater than about the 70th percentile. Another pattern of elevated copper and zinc values was returned from north and northeast-flowing streams that drain the summit of Mt. Patchet and Turks Nose Mtn. (93H/03). Samples 841291-841293, 841299-841300, and 843012-843013 are all within the upper five percentiles for Zn and range from the 70th percentile to the 95th percentile for Cu.

The above brief analysis of RGS data is designed to highlight the utility of the information base and is not intended as a thorough investigation of the data set. That work remains for the interested individual or company to pursue.

SUMMARY

Mineral exploration within the region has focused primarily on gold-quartz veins and vein replacements in the Wells-Barkerville area of the Barkerville Subterrane. There are, however, a small number of known mineral occurrences in both the Slide Mountain and Barkerville terranes that, together with past exploration results, indicate the potential for volcanogenic massive sulphide mineralization. Data from stream sediment samples (RGS) and soil and lithogeochemical surveys (assessment reports) are anomalous in copper and zinc, and are in close spatial association with mafic volcanics, suggesting the potential for VMS mineralization.

Known mineral occurrences in the region are plentiful, but to date only four with VMS characteristics have been formally identified in MINFILE. These are the Mae (093A 087), Big Gulp (093A 143), Ace (093A 142) and Bow (093H 033). Updated MINFILE descriptions for these prospects, together with the addition of the Frank Creek and Lottie discoveries, are meant to provide the reader with a current overview of these two prospective terranes.

RGS geochemical anomalies occur across the region and may represent buried VMS deposits. Comparison of geochemical patterns surrounding known VMS occurrences in the region may reveal spatial relationships between anomalous elements which would aid in the interpretation of multi-element stream sediment anomalies, particularly where the RGS archive program has reported a broader suite of elements. Lett et al. (1998) point out that selenium and arsenic in soil and till are reasonable pathfinder elements for precious metal mineralization associated with massive sulphide deposits in the Kootenay Terrane. A more comprehensive review of the recently re-released RGS data for mapsheet 93A is recommended so that one can take advantage of the trace element associations not available in the earlier RGS data set.

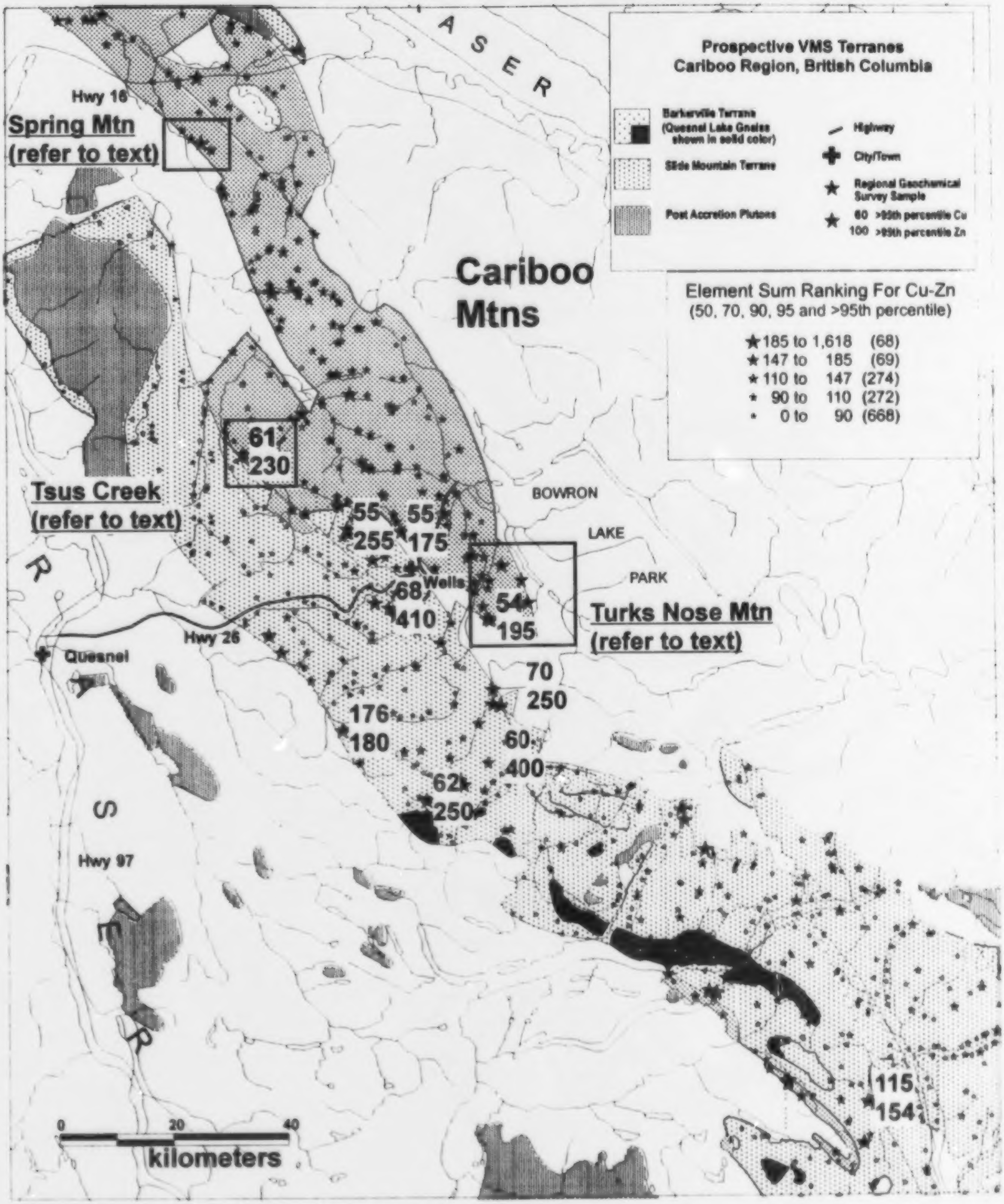
Prospective VMS Terranes
Cariboo Region, British Columbia
Barkerville Terrane (Quesnel Lake Gneiss shown in solid color)
Slide Mountain Terrane
Post Accretion Plutons
Highway
City/Town
Regional Geochemical Survey Sample
60 >95th percentile Cu
100 >95th percentile Zn
Element Sum Ranking For Cu-Zn
(50, 70, 90, 95 and >95th percentile)
185 to 1,618 (68)
147 to 185 (69)
110 to 147 (274)
90 to 110 (272)
0 to 90 (668)
F R A S E R
Hwy 16
Spring Mtn
(refer to text)
Cariboo
Mtns
61
230
Tsus Creek
(refer to text)
55
255
55
175
BOWRON
LAKE
PARK
68
410
Wells
54
195
Turks Nose Mtn
(refer to text)
Hwy 26
Quesnel
70
250
176
180
60
400
62
250
Hwy 97
115
154
0
20
40
kilometers

Figure 2. Distribution of RGS sample locations in Barkerville Subterrane and Slide Mountain Terrane. Boxed areas, referred to in the text, include some of the sites where copper and zinc values exceed the 95th percentile.

Exploration for new massive sulphide discoveries in either the Slide Mountain or Barkerville terranes should focus on recognized stratigraphic intervals that host known mineral occurrences. Within the Barkerville Terrane, the fine-grained phyllites of the Downey succession (Snowshoe Group), interpreted to be altered mafic tuffs, are prospective for Besshi-type VMS deposits. Within the Slide Mountain Terrane, stratigraphic intervals dominated by mafic volcanic rocks of the Antler Formation are prospective for Cyprus-type VMS deposits.

The Lottie and Frank Creek discoveries provide concrete evidence for the presence of volcanogenic massive sulphide systems in Slide Mountain and Barkerville terrane rocks, respectively.

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KNOLL (093M 100)

By Paul J. Wojdak and Daniel Ethier

LOCATION:	Lat. 55°15.2' Long. 127°07.3' (93M/6E)
	OMINECA MINING DIVISION. The property is located in the Harold Price Creek valley approximately 60 kilometres north of Smithers, British Columbia.
CLAIMS:	Knoll 1-3 (3 units)
ACCESS:	North on Highway 16 from Smithers for 48 kilometres to the Suskwa forest service road, 17.2 on the Suskwa road, and finally 13 kilometres on a deactivated spur road to the property.
OWNER/OPERATOR:	Daniel Ethier
DEPOSIT TYPE:	Epithermal massive sulphide
COMMODITIES:	Silver, zinc, lead

GEOLOGIC SETTING OF THE KNOLL PROPERTY: AN ESKAY CREEK TARGET IN CRETACEOUS RHYOLITE

INTRODUCTION

The Knoll property is located in the Harold Price Creek valley approximately 60 kilometres north of Smithers, B.C. The claims cover a steep-sided bedrock knoll, about 600 metres long, 300 metres wide and 60 metres high, on the north side of Harold Price Creek near the centre of the valley. The location is 3 kilometres above the confluence of Harold Price Creek and the Suskwa River. The knoll is a pronounced topographic anomaly, with geologic significance, within the broad U-shaped valley bottom. Access to the claims has been rendered more difficult by road deactivation on the north side of the Suskwa - Harold Price valley, including removal of the bridge across the Suskwa River. Current access is by helicopter, or by hiking 1 kilometre from the Hamblin Main forest service road at the 11 kilometre sign, which requires wading across Harold Price Creek. Harold Price Creek is the main stem of the Suskwa River and crossing on foot should not be attempted during high water. The property was examined by the senior author on October 18, 1999.

HISTORY

Mineralization was discovered on the Knoll claims by Daniel Ethier in May 1983 and he prospected the claims during the two succeeding years (Ethier, 1985). Goldpac Investments Ltd. optioned the property and in 1988 built an access trail and performed geological, magnetic and induced polarization surveys followed by diamond drilling. That work was not filed for claim assessment, and there was no further exploration until Daniel Ethier completed a soil geochemical survey in 1999. His work was supported by a B.C. prospector grant.

REGIONAL GEOLOGY

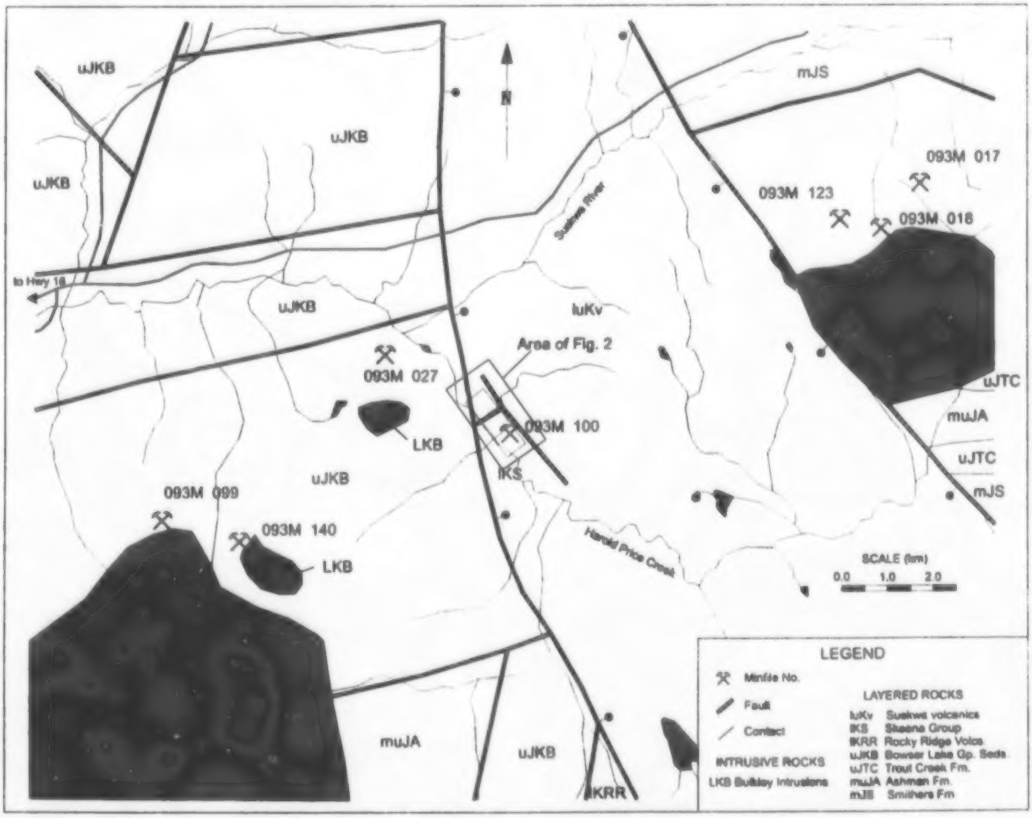
The regional geology has been mapped and compiled by Richards (1980, 1990). The Suskwa – Harold Price area is underlain by volcanic and sedimentary rocks of the Hazelton, Bowser Lake, Skeena and Kasalka groups. These rocks are exposed along the north side of the Skeena Arch, a transverse feature of the Stikine Terrane. The area of Harold Price Creek (Figure 1) is a northwest-trending graben, 8 to 10 kilometres wide, filled with volcanic rocks of andesite to rhyolite composition. In the Suskwa – Harold Price area, these rocks were mapped as the Suskwa volcanics by Richards (1990), and were considered to be part of the Late Cretaceous Kasalka Group. However, elsewhere in central British Columbia the Kasalka Group is strictly subaerial, is exclusively porphyritic andesite and sits with angular discordance on Early and mid-Cretaceous volcanic and sedimentary units of the Skeena Group. The Suskwa volcanics are lithologically similar to a succession of submarine volcanics in the Babine Lake area that have recently been dated at 104-107 Ma (MacIntyre et al., 1997). These rocks, and possibly the Suskwa volcanics, are correlative with the mid-Cretaceous Rocky Ridge volcanics of the Skeena Group (Bassett and Kleinspehn, 1996). The Suskwa volcanics strike parallel to the bounding faults and dip inward, forming a syncline, which suggests this down-dropped block may be a caldera (Richards, 1988).

Figure 1 shows the Knoll claims are near the southwest fault margin of this hypothesized structure.

Older rocks are exposed on both flanks of the down-dropped fault block. and comprise the upper formations of the Hazelton Group and overlying Bowser Lake Group. Hazelton Group units include marine sedimentary and volcanic rocks of the Lower Jurassic Nilkitkwa Formation and fossil-rich, shallow-marine sedimentary rocks of the Middle Jurassic Smithers Formation. Hazelton Group strata are unconformably overlain by conglomerate, sandstone, siltstone, shale and coal beds of the Upper Jurassic to Lower Cretaceous Bowser Lake Group. Late Cretaceous intrusive rocks of the Bulkley intrusive suite cut the sedimentary assemblages. Crustal extension and block faulting in Late Tertiary or younger time has produced the present Basin and Range style geomorphology of west-central British Columbia.

KNOLL PROPERTY GEOLOGY

The Knoll claims were subdivided into three blocks, inferred to be bounded by faults, by Leask et al. (1988). Their interpretation is adopted here and shown in Figure 2. The northwest block is underlain by a sequence of feldspathic sandstone, argillite and thin-bedded, felsic ash tuff, which is correlated with the Skeena Group by Leask et al. (1988). No bedding attitudes are recorded on their geologic map. Different source areas are suggested by the intermixing of clean sandstone and carbonaceous argillite. The laminar-bedded, felsic ash tuff is interbedded with sandy material containing rounded sedimentary grains. This unit was problematic for Leask and co-workers who changed their name for the rock from a 'light and dark banded sedimentary rock', to 'flow-banded rhyolite' during the course of the drilling program. Two samples were selected by the author from drill core and studied petrographically by J.F. Harris (written comm., 2000) who concludes the rock is a "bedded ash tuff of plagioclase-rich (keratophyric) composition" with characteristics that are "contra-indicative of rhyolite". Micritic calcite was also noted. A small Bulkley granodiorite stock intrudes the tuff-sedimentary sequence.


uJKB
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N
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Suskwa River
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093M 027
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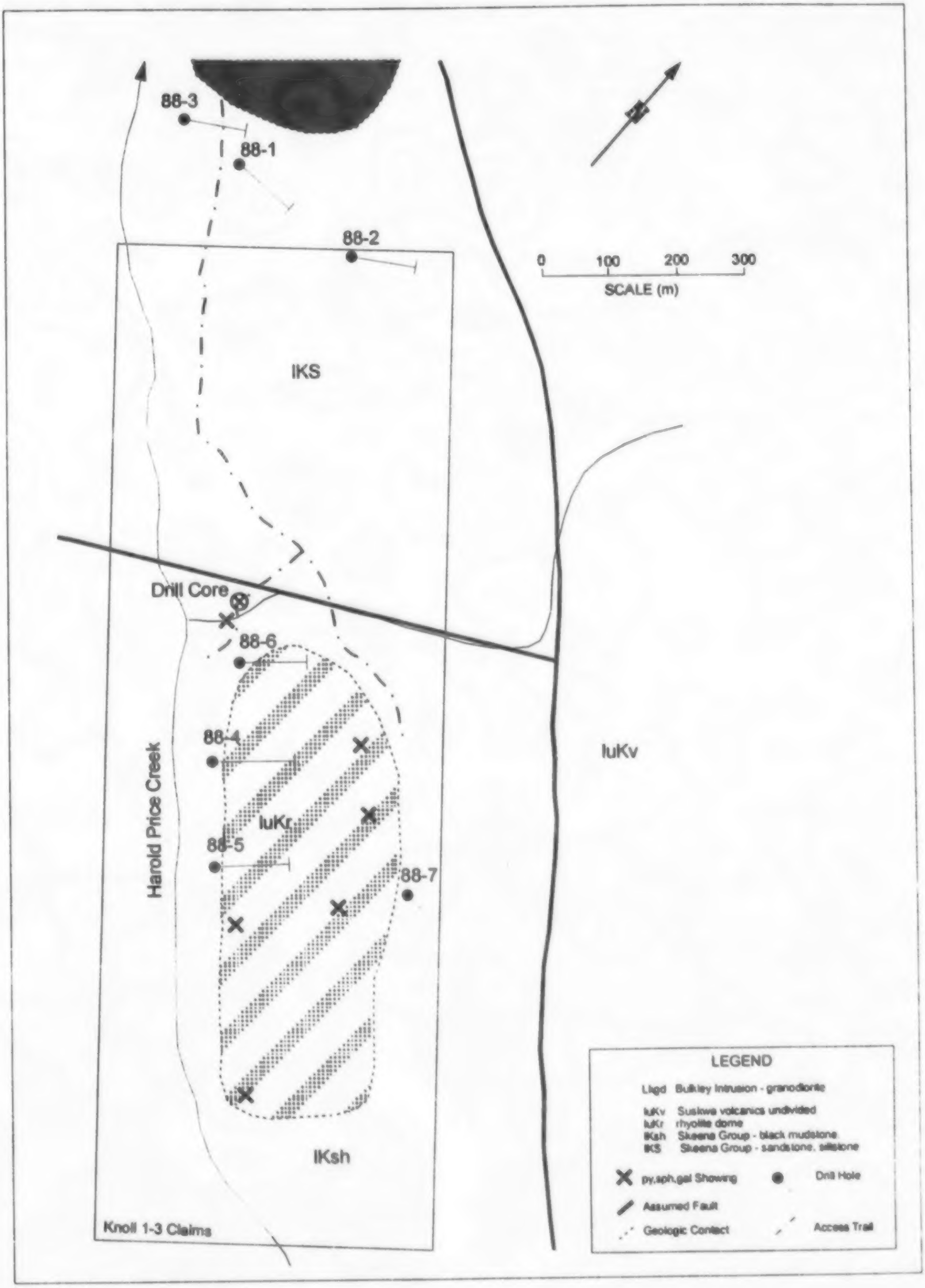
LKB
Harold Price Creek
SCALE (km)
0.0 1.0 2.0
muJA
uJKB
lKRR
LEGEND
Minfile No.
Fault
Contact
INTRUSIVE ROCKS
LKB Bulkley Intrusions
LAYERED ROCKS
luKv Suskwa volcanics
lKS Skeena Group
lKRR Rocky Ridge Volcs.
uJKB Bowser Lake Gp. Seds.
uJTC Trout Creek Fm.
muJA Ashman Fm.
mJS Smithers Fm

Figure 1. The Suskwa volcanic basin (and possible caldera) - geologic setting of the Knoll claims.


88-3
88-1
88-2
0
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SCALE (m)
IKS
Drill Core
88-6
88-4
luKr
88-5
88-7
luKv
Harold Price Creek
IKsh
Knoll 1-3 Claims
LEGEND
Llgd Bulkley Intrusion - granodiorite
luKv Suskwa volcanics undivided
luKr rhyolite dome
lKsh Skeena Group - black mudstone
lKS Skeena Group - sandstone, siltstone
py,sph,gal Showing
Drill Hole
Assumed Fault
Geologic Contact
Access Trail

Figure 2. Knoll property geology, showing structural-lithographic panels

The most interesting rocks outcrop in the southern block near a prominent knoll. Rocks exposed on the knoll are massive to flow-banded, or spherulitic rhyolite, rhyolite breccia and volcaniclastic conglomerate (Leask et al. 1988). These are assigned to the Suskwa volcanics, which as noted previously, are probably part of the mid-Cretaceous Rocky Ridge volcanics. Much of the exposed rock is frost-shattered blocks but where in place, flow banding is invariably steep. Rhyolite breccias are usually monolithic and highly chaotic. These characteristics are interpreted by Richards (1988) and Leask et al. (1988) to indicate an explosive volcanic centre, probably a vent. A flow-banded rock examined petrographically by J.F. Harris was determined to be rhyolite, consisting of sericitized plagioclase phenocrysts in a very fine intergrowth of quartz and K-feldspar. Rock adjacent to the rhyolite is a poorly exposed, variably graphitic, black mudstone to argillite. The topographic expression of the knoll is interpreted to result from erosion of the soft black mudstone, exposing the resistant rhyolite dome. MacIntyre et al. (1997) and Tackaberry (1999) describe a similar suite of rocks in the Old Fort Mountain area at Babine Lake where an arcuate chain of massive, flow-banded, sericitized rhyolite domes with spherulitic textures are emplaced into marine sediments of the Skeena Group. Underlying and in part interbedded with the sediments are dacitic to basaltic flows and felsic pyroclastic rocks of the Rocky Ridge volcanics. As mentioned previously, the rhyolite domes and volcanic rocks give isotopic ages of 104-107 Ma, indicating a mid-Cretaceous (Albian) age. Black graphitic mudstones interbedded with the volcanic rocks and intruded by the rhyolite domes locally contain Albian macrofossils. The Fireweed polymetallic deposit is hosted by a similar sedimentary-volcanic succession.

The third lithologic panel lies to the east and is separated from the Skeena Group tuff-sedimentary sequence and the rhyolite vent assemblage by a major northwest fault (Leask et al., 1988). Rocks in this block were not examined by the senior author, but are described by Leask et al. as consisting of a thick assemblage of feldspar-phyric andesite and dacite, and massive volcanic conglomerate of the Kasalka Group. The latter is tentatively interpreted as debris flows related to the Suskwa caldera.

MINERALIZATION AND DIAMOND DRILLING

Mineralization on the Knoll claims comprises disseminations and veinlets of pyrite, sphalerite and galena in rhyolite breccia and lapilli tuff. Disseminated pyrite and manganese staining are widespread in the rhyolite (Ethier, 1985). Analytical results of ten grab samples by Ethier are listed in Table 1. These include samples of sub-outcrop of pyritic rhyolite breccia in Harold Price Creek, southwest of holes 88-4, 5 and 6, an area not tested by drilling. These show high levels of lead, zinc and arsenic, and locally in silver and cadmium. Gold and silver values are anomalous, but modest.

Seven holes, totaling 978 metres, were drilled on the property and these were collared to test induced polarization anomalies. Most of the core is stored in a rack on the property and is fairly well preserved (Figure 3). However, core from the final three holes is stacked on the ground which will cause the boxes to rot, and make the core difficult to work with. Holes 88-1, 88-2 and 88-3 were all drilled at -45° and provide a section through the tuff-sedimentary sequence in the northwest fault block. Bedding to core angles are 45° to 60°, implying the strata are either very steep or sub-horizontal. A sub-horizontal

TABLE 1. KNOLL CLAIMS ANALYTIC DATA

Sample	Au g/t fire assay	Ag ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Cd ppm	Cu ppm	Fe %	Ba ppm
KN-503	0.01	0.2	60	157	50	5	<1	72	2.75	80
KN-504	0.01	<0.2	10	101	10	5	<1	67	7.17	250
KN-505	0.01	12.2	4008	1219	180	25	2	16	3.89	70
KN-506	0.01	2.6	1346	2117	70	5	11	7	2.38	60
KN-507	0.01	9.8	5572	6067	150	10	40	10	4.31	50
KN-508	0.01	47.4	>10000	>10000	1520	40	>100	61	5.86	60
KN-509	0.03	8.8	1890	1407	785	10	<1	10	5.07	50
KN-510	0.01	3.6	556	1452	5155	15	<1	9	9.29	30
KN-511	0.03	1.8	246	1387	>10000	20	<1	27	8.36	50
KN-512	0.02	1.6	136	305	120	5	<1	10	4.24	100

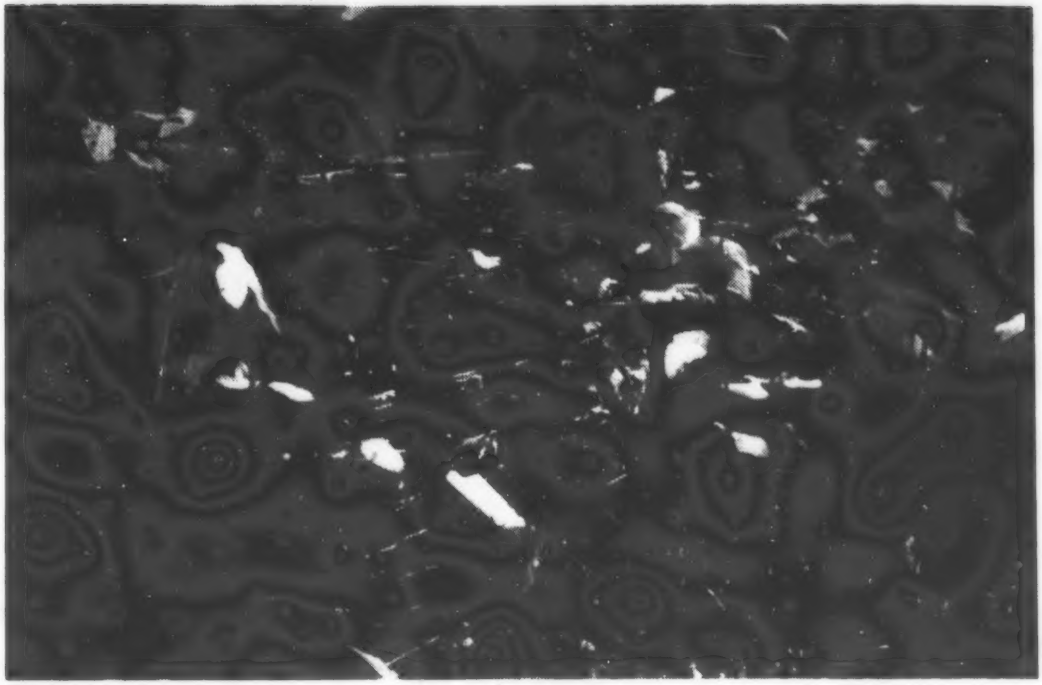

Figure 3. Claim owner, Dan Ethier, examining 1988 drill core on the Knoll property.

attitude is the favoured interpretation because this would be consistent with regional bedding attitudes determined by Richards (1980, 1990). Mineralization intersected by these drill holes is mainly fracture-controlled pyrite, pyrrhotite and arsenopyrite with associated quartz and calcite. The strongest alteration is in hole 88-3, closest to the granodiorite stock, and consists of bleaching in argillite which is best classified as propylitic alteration. The highest grade intercept was also in drill hole 88-3 - 0.51% Pb, 1.32% Zn, 9.58% As, 30 ppm Ag and 1610 ppb Au over 1.0 metre.

Holes 88-4, 88-5 and 88-6 were collared at the base of the knoll near Harold Price Creek and drilled at -45° to the northeast, into the interpreted rhyolite dome. Hole 88-4 went from rhyolite breccia, consisting of angular rhyolite fragments in a muddy black matrix at the top of the hole, into flow-banded rhyolite at a depth of 32.5 metres. Maximum clast size in the breccia is at least 10 centimetres. Flow banding in the rhyolite is contorted and discontinuous, typical of viscous magma flow. Pyrite, sphalerite and galena occur as disseminations and veinlets. After 96 metres of rhyolite, the hole entered a monotonous sequence of graphitic black argillite below the rhyolite and was stopped at 204 metres. Hole 88-5 was also collared in rhyolite breccia, similar to hole 88-4, but in this hole the fragments are smaller, more rounded and a more uniform 0.5 to 1 centimetre in size. This is interpreted to indicate sedimentary reworking and deposition further from a vent source. A few 10-centimetre, irregular shaped rhyolitic fragments were also observed and these may be air-fall ejecta from a nearby vent. The hole did not intersect massive rhyolite.

Hole 88-6 is intriguing, but unfortunately the core is less well preserved. The hole penetrated strongly sericitized rhyolite agglomerate. Clasts are very angular, sericitized shards, several centimetres in size, in a siliceous matrix. Thin section examination by J.F. Harris confirms "the rock is a coarse pyroclastic made up of lapilli of intensely sericitized, more or less quartzose keratophyre in an unaltered, ashy matrix of rhyolite composition." The drill log records disseminated pyrite, sphalerite and galena throughout. Predictably, lead and zinc are anomalous. The highest silver value is 13.8 ppm, also anomalous, but gold was not determined. At a depth of 129 metres, the hole passed from rhyolite into graphitic black argillite. Hole 88-7 was drilled east of, and away from the rhyolite dome. It was lost in sheared argillaceous rock 32 metres from the collar.

MINERAL POTENTIAL

Other mineral showings near the Knoll have important implications for the type of mineralization that may lie undiscovered on the Knoll claims. The Max prospect (93M 027), just 3 kilometres northwest (Figure 1), contains galena, sphalerite, jamesonite and arsenopyrite. Most mineralization is fracture controlled and apparently related to a diorite stock of the Bulkley intrusive suite. However, some mineralization is described as "massive" and bedding controlled. Assays up to 1248 g/t Ag over 0.5 metre and 22.7 g/t Au over 15 centimetres are reported in assessment reports. Like the Knoll showing, the Max lies very close to the bounding fault of the Suskwa volcanic basin.

The Skilokis prospect (93M 099) comprises a series of amphibole (grunerite)-quartz-magnetite-apatite-sulphide veins in the hornfels halo of yet another Bulkley quartz diorite intrusion. The veins contain arsenopyrite, pyrrhotite, pyrite, galena, sphalerite, stibnite, chalcopyrite and possibly tetrahedrite. A 30-centimetre core sample assayed 829 g/t Ag and 2.4 g/t Au. The Skilokis veins are 6 kilometres west of the Suskwa volcanic basin. Mineralization at the Max and Skilokis prospects exhibits a strong Ag-Au-As-Sb-(Zn-Pb) signature.

CONCLUSIONS

There is no evidence of any correlation between the northwestern and southern stratigraphic panels. Sedimentary rocks in the northwest panel are clean sandstone and non-graphitic argillite, typical of shelf to fluvial-deltaic facies of the upper Skeena Group. In contrast, the southern block contains black graphitic mudstone and interbedded rhyolitic tuffaceous rocks intruded by rhyolite domes. These rocks are probably mid-Cretaceous in age and part of the Rocky Ridge volcanics. The Knoll is an explosive rhyolite dome, mineralized with base metals and silver, emplaced into graphitic mudstone. A recent petrographic and lithogeochemical study of similar rhyolite domes and volcanic-sedimentary hostrocks in the Babine Lake area by Tackaberry (1998) concluded that the Rocky Ridge volcanics of the Skeena Group have potential for volcanogenic massive sulphide (VMS) deposits of the Kuroko or Eskay Creek type. Furthermore, other showings in the vicinity of the Knoll show a strong Ag-Au-As-Sb signature to mineralization, suggesting very good potential for an Eskay Creek-type deposit. On the Knoll claims, the southeast vector given by holes 88-6, 88-4, 88-5 is progressively more distal from the rhyolite vent, and perhaps also from mineralization. Conversely, strongest potassic alteration was seen in Hole 88-6. Exploration should focus west to northwest of drill hole 88-6.

ACKNOWLEDGEMENTS

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1998-99 BRITISH COLUMBIA PROSPECTORS ASSISTANCE PROGRAM

By Garry Payie, P.Geo.
Program Coordinator

HIGHLIGHTS

Prospectors in the 98/99 Prospectors Assistance Program (PAP) year were successful at finding a number of new mineral occurrences and six prospectors entered into agreements that will see these following properties developed further.

- **Bizar/Goldstrike** - a vein system in central B.C. with gold, copper and bismuth optioned by Cassidy Gold Corp who must spend $500,000 over 4 years on development.
- **Cam-Gloria** - an exciting quartz vein-hosted gold occurrence near Adams Lake. Teck Corporation is the option holder and spent about $100,000 in 1999.
- **Ladybug** - this lead-zinc prospect near Anglemont in central B.C. was optioned to Cross Lake Minerals who drilled 5 holes in 1999.
- **Lottie** - a new massive sulphide discovery near Wells that was optioned to Eureka Resources Inc and subsequently to Hudson Bay Mining and Smelting who will spend $400,000 on the property in 2000.
- **Quill** - located in northwest B.C., this gold-sulphide-quartz vein system was drilled in 1999 by option-holder Petra Resources Corp. The program cost is estimated at about $150,000.
- **Zymo** - located near Smithers, this new porphyry prospect was optioned to Freeport-McMoRan who drilled 4 holes totaling 1600 metres in 1999.

Several other significant finds may be optioned soon and a number of discoveries from previous PAP programs continue to be developed.

INTRODUCTION

The renewal of the 1998-99 Prospectors Assistance Program (PAP) was announced on April 9, 1998 by Energy and Mines Minister Dan Miller. This $500,000 per year program is designed to promote grassroots prospecting for new mineral deposits in British Columbia.

The Program is available to individual prospectors who hold a valid British Columbia Free Miners Certificate. Successful applicants can receive a maximum of $10,000 to cover 75% of the eligible expenses. The grant is paid in 2 installments, an initial 50% award on approval of the project proposal and a final 50% award upon approval of the final report.

The Prospectors Assistance Program is administered in Victoria by staff of the Geological Survey Branch. The regional geologists of the Mines Branch were involved in all aspects of the program and are responsible for rating applications and for approving final reports.

PROSPECTING PROGRAMS

Deadline for applications was set for the third Monday in April - in the 1998 program year, April 19. A total of 102 applications were received by the deadline. Applications were evaluated on the basis of the following criteria:

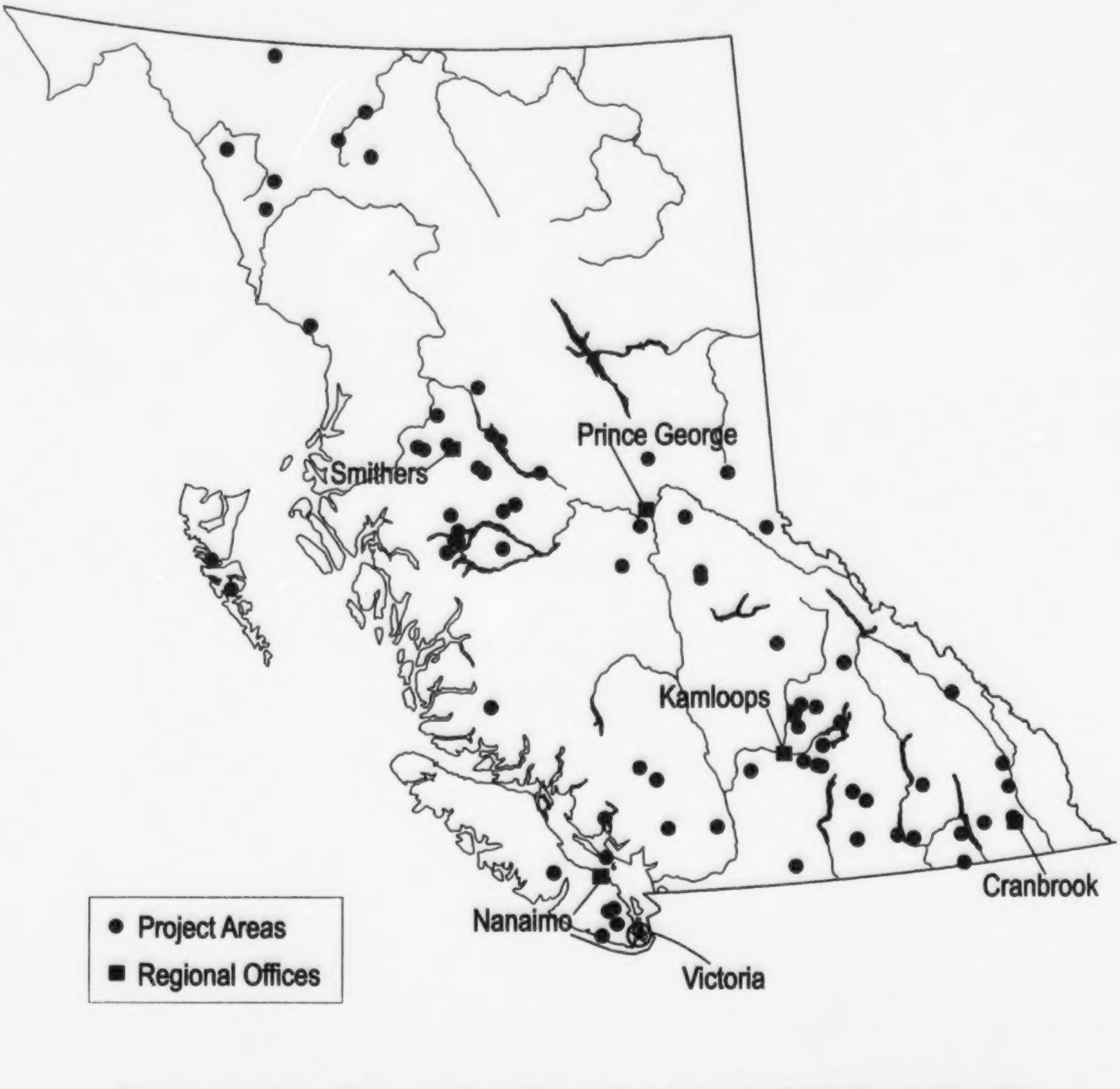
• Quality and documentation of proposal	45%
• Financial commitment of applicant	25%
• Experience and training of applicant	10%
• References and past performance	20%

All applications were initially reviewed by the Victoria office to ensure that they met the criteria as outlined in the guidebook. Qualifying applications were then sent to the appropriate regional geologist for evaluation by May 14. The five Regional Geologists reviewed all applications for their respective regions and rated them according to specific evaluation guidelines.

Grant amounts were determined by allowing the 26 highest rated applicants 100 per cent of their maximum allowable grant (to a maximum of $10,000) and the following 26 applicants, 75 per cent of the maximum allowable grant (up to $7,500). A total of 52 grants averaging $8,251 were approved, for a total of $429,068.

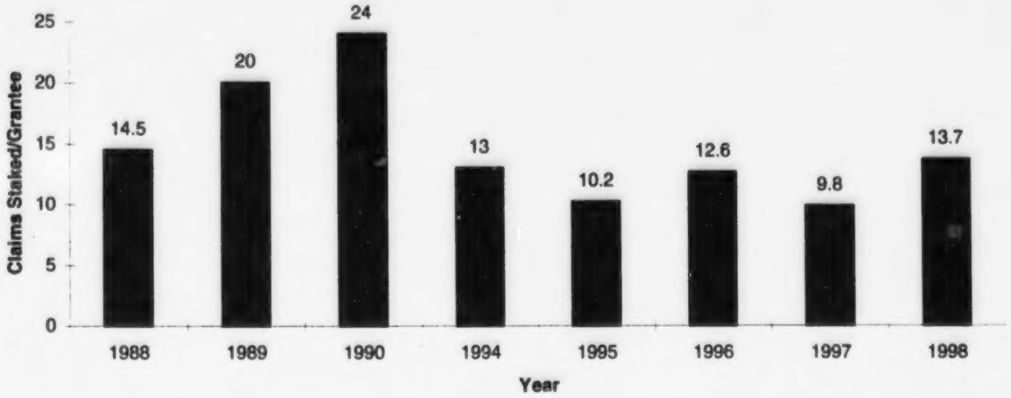
The prospecting programs were distributed throughout the province as shown in Figure 1. Of the 102 applicants, 43 (42.2%) had never received a grant before.

Figure 1: Distribution* of 1998/99 Prospectors Assistance Grant Projects


Smithers
Prince George
Kamloops
Cranbrook
Nanaimo
Victoria
● Project Areas
■ Regional Offices

*Some programs have multiple prospecting locations and have been assigned more than one plot symbol.

Figure 2



Of the 52 applicants receiving grants, 17 (32.7%) had never received grants before.

Twenty-five of the 49 active grantees staked mineral claims while working under the terms of their grant. A total of 672 units were staked (Table 1). Although the level of staking was up more than 50% from the previous year and roughly matched the levels in 1988 and 1996 (Figure 2), a depressed market for exploration properties is still reflected in the data when compared to other years such as 1989 and 1990.

Final prospecting reports were due in the Victoria office no later than January 31, 1999. These reports were logged in and sent off to the appropriate regional geologist for evaluation. The quality of the program was assessed by the regional geologist in terms of the commitment and ability of the grantee to carry out his or her program as originally proposed. Program elements looked for in the report included the plotting of sample locations and other data on maps of appropriate scale, a good diary of day to day prospecting activity, a summary of overall results and a list of actual expenditures along with major receipts.

The final report evaluation form was returned to Victoria where a final payment cheque was issued to those grantees who had successfully completed their program.

TABLE 1: SUMMARY OF PROSPECTING ACTIVITIES

Item	*1988-89*	*1989-90*	*1990-91*	*1994-95*	*1995-96*	*1996-97*	*1997-98*	***1998-99***
Total Prospecting days in the field	4709	3414	2672	2816	2440	3102	1846	2459
Average prospecting days in the field, active grantees	37	46	35	45.4	41.3	51.7	45	50
No. of Active Grants	128	74	76	62	59	60	41	49
No. of claim units staked during/after prospecting activity	1860	1483	1843	816	604	759	403	672
No. of Units Staked/ActiveGrantees	14.5	20	24	13	10.2	12.6	9.8	13.7
No. of Option agreements (signed or under negotiation)	23	8	6	15	16	14	2	8

RESULTS TO DATE

The following notable developments and prospecting discoveries are an indication of the programs value in the search for untapped mineral wealth, the first step towards developing tomorrow's mines for British Columbia.

NEW DISCOVERIES AND DEVELOPMENTS

Steve Bell staked the **Palomino** claims on an old, but undrilled shear/vein and porphyry copper-gold prospect near Houston. The shear occurs in intermediate volcanics of the Hazelton Group; a quartz monzonite dike containing copper mineralization is located nearby. A 40-centimetre sample across the shear assayed 42.5 g/t gold, 171.4 g/t silver and 9.4% copper.

Arnd Burgert discovered massive sulphides in a pendant of the Gambier Group, north of Powell River. Pyrite, sphalerite and chalcopyrite form a 20-centimetre thick lens traceable for 8 metres within felsic volcanics. Samples from the **Lorax** prospect yielded 1.43% zinc, 0.45% copper, 19 grams per tonne silver, 0.01% cobalt and 0.01% cadmium.

Dan Ethier trenched a sheeted vein stockwork in early Jurassic syenite on the **Bob** claims **(Limpoke)** in the Telegraph Creek area. He obtained 0.8% copper and 0.65 g/t gold over 5.6 metres. The geological setting is similar to that at Galore Creek.

Bruce Holden continues to develop a precious opal deposit on his **Northern Lights** property in the Whitesail range. Opal occurs in Tertiary basalt as vesicle filling and as matrix replacement in lahar. The opal was mined by hand and a helicopter was used to remove 800 kg for a marketing study.

Frank O'Grady has an option agreement pending on his Brancheye property located near **Skookumchuck** River about 28 kilometres north of Kimberly. O'Grady located the bedrock source of malachite float in 1996 while prospecting the area under the auspices of a PAP grant. The copper occurrence comprises minor blebs of chalcopyrite and malachite as disseminations and in thin quartz veinlets in phyllite host. The mineralized unit has been traced for about 125 metres and was determined to be 1.5 metres thick. O'Grady further explored the property in 1998 with the aid of another PAP grant and was able to define a copper soil anomaly with dimensions of 150 by 120 metres.

Peter Newman discovered an interesting new gold-silver-copper-zinc prospect in the Pemberton area after receiving a 1997 PAP grant. Following his receipt of PAP grant in 1998, Mr. Newman made further mineralized float and outcrop discoveries which extended the length of the mineralized zone on the **Skumakum** claims to approximately 2 kilometres. Mineralization is hosted in a sheared, mixed volcanic package that is a potential polymetallic VMS target similar to that drilled by Teck Corporation on the neighbouring Avalanche property.

John Telegus has furthered the delineation of a new copper-gold prospect on his **Alberni North** claims west of Port Alberni. Argillically-altered Karmutsen basalt hosts a 300-metre long quartz stockwork that yielded values up to 1.3% copper and 30 g/t gold. Augite porphyry dikes, related to the Bonanza Group intrude the mineralized area. A soil survey carried out by Telegus has outlined a 350 by 600-metre area that is anomalous in copper, gold and zinc.

Steve Traynor conducted exploration on the **Arsenault** property in northwestern B.C. near the Yukon border. Mineralization consisting primarily of pyrite and chalcopyrite is associated with chlorite schists and quartzites, occurring mainly as fine disseminations and blebs but occasionally as semi-massive accumulations. A chip sample taken across 7.5 metres yielded 0.46% copper and 1.3 g/t gold. New soil and rock geochemical data from this property, produced as a result of Traynor's 1998 PAP grant, has generated new VMS targets.

PROPERTIES OPTIONED

Bizar/Goldstrike

Located near Blue River, Bizar is a gold-bismuth-copper prospect discovered by **Leo Lindinger** during the execution of his 1998 PAP program, for which he received a $10,000 grant. Quartz-sulphide veins cut micaceous quartzite and mica schist. A chip sample across a 20-centimetre vein yielded 56 g/t gold, 0.5 per cent bismuth and 0.34 per cent copper, along with anomalous silver, cobalt, molybdenum, nickel, selenium, tellurium and tungsten. **Cassidy Gold Corp.** optioned the Bizar claims in 1998 and has renamed the property **Goldstrike**. Cassidy drilled five short holes in late 1999, intersecting several narrow veins with anomalous gold values. The best was 6 g/t over 20 centimetres. The company was to have spent $50,000 on exploration and development in the first year (1999) and a total of $500,000 by the end of the fourth year. Further worked is expected in 2000.

Cam-Gloria

Located west of Adams Lake, the Cam-Gloria gold prospect was discovered by prospector **Camille Berube** in May, 1997 while following up two anomalies from a BC Geological Survey till geochemistry survey. A quartz vein hosted by granitic rocks contains pyrite, pyrrhotite, and rare galena and chalcopyrite and is up to 10 metres wide and 200 metres in length. Berube conducted blast trenching, hand trenching and geochemical sampling of the vein in 1998, supported by a $10,000 PAP grant program. In mid 1999, the property was optioned to **Teck Corporation** who conducted a mapping program followed by excavator trenching and the drilling of 7 holes. Expenditures by Teck in 1999 were approximately $100,000. Teck is considering further work on the property in 2000.

Ladybug

Situated on Mount Fowler, north of Anglemont, the Ladybug prospect was originally discovered by **N. Stephanishin** and **Dave Pipe** under a 1996 PAP grant. In 1998, **Leo Lindinger**, working with a $10,000 PAP grant, made further discoveries on the property. Disseminations, stringers and massive zones of sphalerite, galena, magnetite and chalcopyrite occur within the Eagle Bay Formation. A weighted average of several channel samples assayed 1.90% zinc, 1.12% lead, 78.2 g/t silver and 0.19% copper over 9 metres. Similar mineralized outcrops occur 30 metres to the northeast and 40 metres to the southwest. The prospect has the appearance of a stratabound Shuswap-type deposit but the presence of calc-silicate minerals indicate skarn affinities. **Cross Lake Minerals** optioned the property in December 1998 and followed in 1999 with the drilling of 5 short holes. The property was subsequently returned to the vendors.

Lottie

Located just north of the town of Wells, the Lottie claim was staked by 1998 PAP grantee **Martin Peter** in order to cover the area around a new discovery of massive sulphide float. Boulders of mineralized chert and silicified, altered volcanic rock occur over a distance of about 75 metres in an area underlain by the Mississippian Antler Formation, potential host to VMS-style mineralization. A sample from one boulder assayed 24.3% copper, 0.4 gram per tonne gold, 19.6 grams per tonne silver, 0.06% cobalt, 0.12% molybdenum, 0.02% lead and 0.04% zinc. The boulder that this sample was taken from was not fully exposed and its full size was not determined. The Lottie was optioned to **Eureka Resources Inc.** early in 1999 and an exploration program was to occur later in the year. Eureka optioned the Lottie to Hudson Bay Mining and Smelting in 1999 who will spend $400,000 on exploration in 2000 on a now combined Lottie and Bow property called Lottie Lake. This group consists of 850 contiguous claims.

Quill

The Quill property is located 65 kilometres northwest of Stewart, lying on McQuillan Ridge at the confluence of the Unuk and South Unuk rivers. Mineralized boulders were found by **Allan St. James** in an area where Jurassic diorite intrudes Stuhini and Unuk River volcanic and sedimentary rocks. A large angular diorite boulder with quartz vein containing chalcopyrite, pyrite and marcasite yielded 102 grams per tonne gold, 36 grams per tonne silver, 5.32% copper, 0.01% lead and 0.01% zinc. Other sulphide-bearing quartz vein float contained predominately galena and lead. Prospecting did not locate the source of the high-grade gold-quartz vein boulders but a 250-metre-long open-ended conductor underlying the boulder field was defined during the 1998 PAP-funded geophysics program. With a drill target now in place, **Petra Resources Corp.** optioned the Quill property at the end of 1998 and completed 7 holes in 1999 totaling 410 metres.

Zymo

This new porphyry copper-gold target west of Smithers was identified in 1996 by PAP grantee, **Robin Day**. The targets were further outlined and defined with the help of grants in 1997 and 1998. In 1998, Freeport Copper Company (FCC), a subsidiary of Freeport McMoRan Copper and Gold Inc., entered into a option agreement to carry out exploration on the Zymo. Six holes were subsequently drilled totaling 1600 metres in 1999. The Zymo property is underlain by a phyllic-altered, pyritic quartz diorite stock with local copper, zinc, lead, silver and gold mineralization and anomalous arsenic+/-antimony rock geochemistry. The presence of extensive phyllic alteration with local copper-silver-gold mineralization is considered encouraging. The property is similar to the Louise Lake prospect, 7 kilometres to the east, which has a calculated resource of 50 million tonnes.

ACTIVE PROSPECTS IDENTIFIED BY PREVIOUS GRANTS PRIOR TO 1999

The following are some of the known active properties picked up by companies because of work by PAP grantees under previous programs from 1995 to 1997.

Ample-Goldmax

This property is located on both sides of Cayoosh Creek, a few kilometres west of Lillooet. Given an $8,600 Prospectors Program grant in 1995, **Dave Javorsky**'s exploration work produced data which helped option the property (50% Javorsky/50% Gary Polischuk) to **Homestake Canada Inc.** in the fall of the same year. Subsequent drilling by Homestake (26 holes, 1996-97) encountered mesothermal quartz-carbonate veins with visible gold. Homestake's best hole hit 11.76 grams per tonne gold over 8.2 metres. After Homestake dropped the property, Javorsky/Polischuk optioned it to **Gold-Ore Resources Ltd.** who conducted surface work in 1998 and drilled 9 holes totalling 907 metres in 1999, further extending the zone of known mineralization. Spending by Homestake and Gold-Ore since the first option occurred is reported to total $1.05 million.

Bow

In 1997, two areas of copper±zinc±gold±silver float were staked by **Martin Peter** southeast of Prince George, a direct result of a $5721 PAP award. Samples of massive fine-grained pyrite with faint bands of chalcopyrite, yielded up to 7% copper, 1% zinc, 4 g/t gold and 7 g/t silver. **Eureka Resources Inc.** optioned Peter's Bow claims in December 1997 and identified two prominent airborne EM conductors in 1998. Follow-up surveys further defined the VMS targets which the company plans to drill 1999. The vendor estimates that $200,000 to $250,000 were spent on the Bow in 1998. Eureka subsequently optioned the Bow to Hudson Bay Mining and Smelting in 1999 who will spend $400,000 on exploration in 2000 on the combined Bow and Lottie properties (a group of 850 contiguous claims).

Findlay Creek

These properties are located 35 kilometres northwest of the Sullivan Mine and cover the same stratigraphic sequence which host this world-class deposit. **Tim Termuende** staked initial claims in the Findlay Creek area in early 1995 in anticipation of an airborne geophysical survey funded by the B.C. Geological Survey and the Geological Survey of Canada. Termuende was able to carry out initial prospecting on the Core, Fin and Doc claims in 1995 after receiving a PAP grant in the amount of $8,800. Later in the same year, the claims were sold to **Eagle Plains Resources** and **Miner River Resources** who did follow-up work in 1996, including drilling. **Kennecott Canada Exploration Inc.** optioned the property in 1996 and carried out $1.3 million worth of work in 1997 and 1998 including the drilling of 5 holes. An extensive sheeted vein system containing lead and zinc (with accessory cadmium, copper and tungsten) mineralization was encountered in one drill hole. Another drill hole tested an extensive tourmalinite alteration zone and encountered significant base-metal enrichment over 105 metres. Within this interval, 46 individual thin stratabound mineralized horizons were intersected. Kennecott, electing to direct its exploration southward, dropped the Findlay option in 1999 and picked up the adjoining **Greenland Creek** option from Eagle Plains and Miner River. Kennecott spent $240,000 on a first phase program in 1999 and intends to drill in 2000. The company is committed to spending $2 million over 4 years on this block of 247 claims. **Rio Algom Exploration Inc.** subsequently took an option on the **South Findlay** property (a portion of the original Findlay Creek property) in early 1999 and must spend $2 million over 4 years on the 231 claims. **Billiton Exploration Canada Limited** will make an investment in Eagle Plains Resources in exchange for the right to option the **North Findlay**, the remaining 149 claims of the original Findlay Creek property. Partial funding from the financing was used by Eagle Plains, as operator, to carry out a $400,000 diamond drilling program during 1999. Billiton may earn a 50% interest in the North Findlay and adjoining Hap properties by spending $2,000,000 on exploration over four years.

Hen

After receiving a 1997 PAP grant of $6722, **David Ridley** was able to further explore his Hen showings and identify it as a gold-bearing skarn deposit. Skarn related alteration and local gold mineralization are found at the footwall and hangingwall of a limy sequence. Gold values at the showing average 4 g/t across 2 metres. Ridley was successful in optioning the property to **Mandalay Resources** at the beginning of 1998. The property is located about 75 kilometres northeast of 100 Mile House in the Hendrix Creek area. Ridley continued to prospect adjacent claims after receiving a 1998 PAP grant.

McNeil Creek

The McNeil Creek property is located 18 kilometres southwest of Cranbrook. **Frank O'Grady** explored the area in 1995 and 1996 after being funded by a PAP grant in each of those years. Underlain by Moyie intrusive rock and Middle Aldridge sediments, O'Grady's Phantom, Mar and Cubby claims are the target of a Sullivan-type massive sulphide orebody. In 1996, O'Grady optioned his claims to **Sedex Mining Corp**. In 1998, Sedex drilled a hole to a point just below the Lower-Middle Aldridge contact, encountering minor sulphides. Sedex subsequently optioned the property in 1999 to Webb Bay Resources Ltd. which has committed to spend $1,000,000 over four years.

TRAINING COURSE GRANTS

Funds from grants that were declined were disbursed to various groups throughout B.C. at the end of the fiscal year to provide assistance for training programs. This program recognizes the importance of providing education to develop new prospectors. The following grants were issued:

BC & Yukon Chamber of Mines	$5,000
BC Museum of Mining	$5,000
Smithers Exploration Group	$5,000
Omineca Mining Group	$5,000
Chamber of Mines of Eastern BC	$5,000
Kamloops Exploration Group	$5,000
Boundary Mining Association	$8,000

The Boundary Mining Association which was formed in 1997, received two grants - an initial start up grant of $4,000 in mid 1998 and an additional $4,000 in March 1999.

CONCLUSIONS

Again this year the program produced significant benefits for the province. Grantees were able to option six recently discovered mineral occurrences to mining companies for further exploration. The grant moneys played a critical role in allowing these grantees to find and then develop their discoveries to a level that excited corporate interest. As well, work done by grantees in previous years continues to generate exploration investment in the province. For example, it is known that companies are exploring on five properties worked on by PAP grantees from 1995 to 1997.

The excellent overall performance of the active grantees in 1998 is exhibited by several factors. The average number of prospecting days per grantee was 50.2, which was greater than in all but one of the previous 7 years in which the program occurred. The final report evaluations were high, 68.7% of the active grantees scored 8 out of 10 or higher and only 12.2% scored 5 or lower. These are indicators of the commitment and high quality delivered by the grantees.

The PAP budget was $200,000 in 1986, rising to $400,000 in 1987 and was further raised to $500,000 in 1988, its current funding level. The maximum allowable grant has gone from $5,000 in 1988 to $7,500 in 1989. It was raised to the present maximum of $10,000 in 1994.

Since the end of the 1980s, relatively few companies have been putting up grubstakes for prospectors and the grants have played a much larger role than normal in keeping prospectors active in this province. This year a number of good proposals did not receive funding, a result of the growing number of applications and the higher proportion of grantees receiving the maximum allowable grant.

FOR FURTHER INFORMATION

Please contact the Prospectors Assistance Program office, a Regional Geologist or visit our website:

www.em.gov.bc.ca/mining/Geolsurv/Publications/pap98/pap98.htm

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PRELIMINARY REPORT ON THE COLLECTION AND PREPARATION OF A NEW LAKE SEDIMENT CONTROL STANDARD: APPLICATION TO REGIONAL GEOCHEMICAL EXPLORATION FOR EPITHERMAL GOLD DEPOSITS IN THE CORDILLERA

By Stephen J. Cook

KEYWORDS: Applied geochemistry, lake sediments, control standard, mineral exploration, gold, multi-element, Regional Geochemical Survey.

INTRODUCTION

Geochemical samples submitted to contract laboratories for analytical work should contain appropriate control reference standards to monitor analytical accuracy. Ideally, the control standards used in any given survey should span a concentration range, from background to anomalous levels, for those elements associated with the type of mineral deposit sought. In the case of lake sediments obtained as part of the Regional Geochemical Survey (RGS) program and other studies, a variety of in-house standards (drift monitors) and certified CANMET control standards (Lynch, 1990) are used. There is however a dearth of gold standards at the appropriate concentration levels required for natural lake sediments. Background gold concentrations in most organic-rich lake sediments are very low (generally about 1 ppb), and reliable lake sediment standards with moderately high gold concentrations in the 10 ppb range are rare. Many sediment standards either contain no gold, or have gold in such high concentrations (e.g. > 50 ppb) that they are inappropriate for natural lake sediment suites. Furthermore, gold-bearing control standards which have been artificially mixed and diluted may yield imprecise and unsatisfactory results (Fletcher, 1999).

To fulfill this requirement for an appropriate control standard, a bulk lake sediment sample was collected in August 1997 from Clisbako Lake in the Fraser Plateau (Jackaman *et al.*, 1998). This lake is adjacent to the Clisbako epithermal Au-Ag prospect (MINFILE 93C 016) in the Clusko River map area (NTS 93C/9), and is road accessible from Quesnel. The purpose of this paper is to describe the collection and preparation of the standard and to present preliminary analytical results, with the objective of highlighting this locality as a potential source of lake sediment standard material for regional geochemical exploration for epithermal gold deposits. In light of recent public demand and institutional requirements for implementation of more comprehensive quality control programs at all stages of exploration, mineral exploration companies may want to collect, prepare and characterize their own in-house regional geochemical standards.

GEOLOGICAL SETTING AND PRIOR GEOCHEMICAL STUDIES

Clisbako Lake (elev: ~1280 metres) is located about 100 kilometres west of Quesnel and about 40 kilometres southwest of Nazko in the Fraser Plateau of central B.C. (Figure 1), an area of low to moderate relief and extensive drift cover. Geology of this region has recently been mapped by Metcalfe and Hickson (1995) at 1:50,000 scale. The geological setting of the Clisbako Au-Ag prospect has been described by Dawson (1991), Schroeter and Lane (1992) and Lane and Schroeter (1997). It comprises a high-level adularia-sericite epithermal system hosted by basaltic to rhyolitic tuffs, flows and volcanic breccias of the Eocene Ootsa Lake Group exhibiting moderate to intense silicification and argillic alteration.

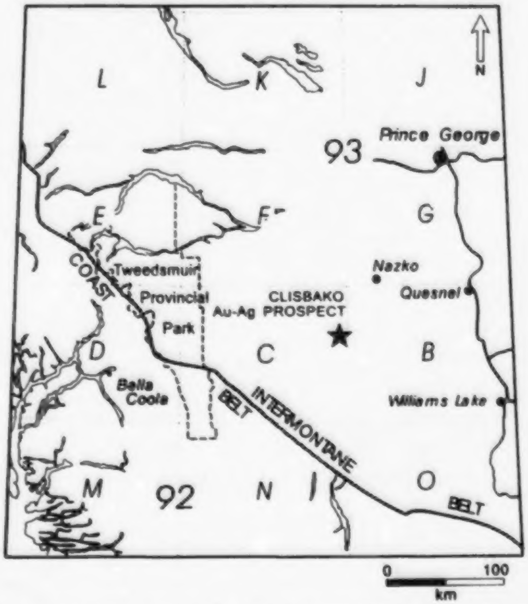

Figure 1. Location of Clisbako Lake and the Clisbako Au-Ag prospect in the Interior Plateau region of central B.C.

Gold mineralization is associated with low-sulphide quartz stockwork zones hosted by north to northeast trending structures.

The lake is about 700 metres long, and comprises a single basin with a maximum water depth of about 9 metres. Two streams drain nearby altered and/or mineralized zones (Dawson, 1991), and enter the lake from the northwest and the south (Figure 2). Prior orientation studies conducted at this site identified elevated concentrations of gold (median: 9 ppb), arsenic (median: 25.5 ppm) and antimony (median: 3.1 ppm) in organic sediments throughout the lake (Cook, 1995; 1997a,b).

SAMPLE COLLECTION, PREPARATION AND ANALYSIS METHODS

The bulk standard material was collected by repeatedly dropping a Hornbrook torpedo sampler from a zodiac anchored at various locations in the shallow western part of the lake (Figure 2), where earlier work (Cook, 1995; 1997a, b) had identified several sites with elevated and homogenous gold concentrations in the 10-14 ppb range. Approximately 125 litres of wet sediment were obtained, filling five 25-litre plastic sample pails. The material was transported back to the field camp, where the lids were removed and the sediment allowed to air dry in the pails for the remainder of the field season. The sediment was then removed from the pails in the Analytical Sciences Laboratory, Victoria, and spread out on large plastic trays where it was permitted to air dry for several months.

The bulk sediment was then sent to CanTech Laboratories, Inc., Calgary for final drying and sample preparation. The sediment was disaggregated in a steel ring mill, screened to minus 80 mesh (< 177 microns) to remove any remaining aggregates, and returned to the Geological Survey Branch. To counter the settling of particle grains in the pails during shipping, the standard material was then further mixed and tumbled in a Patterson-Kelley twin shell dryblender before final division into 15 one-litre plastic jars of about 500 grams of material each. The final weight of the prepared sediment standard was approximately 7.7 kg. Although the initial wet sediment was not weighed, the final bulk volume of approximately 12 litres of standard material corresponds to a reduction in initial field sample volume of approximately 10:1.

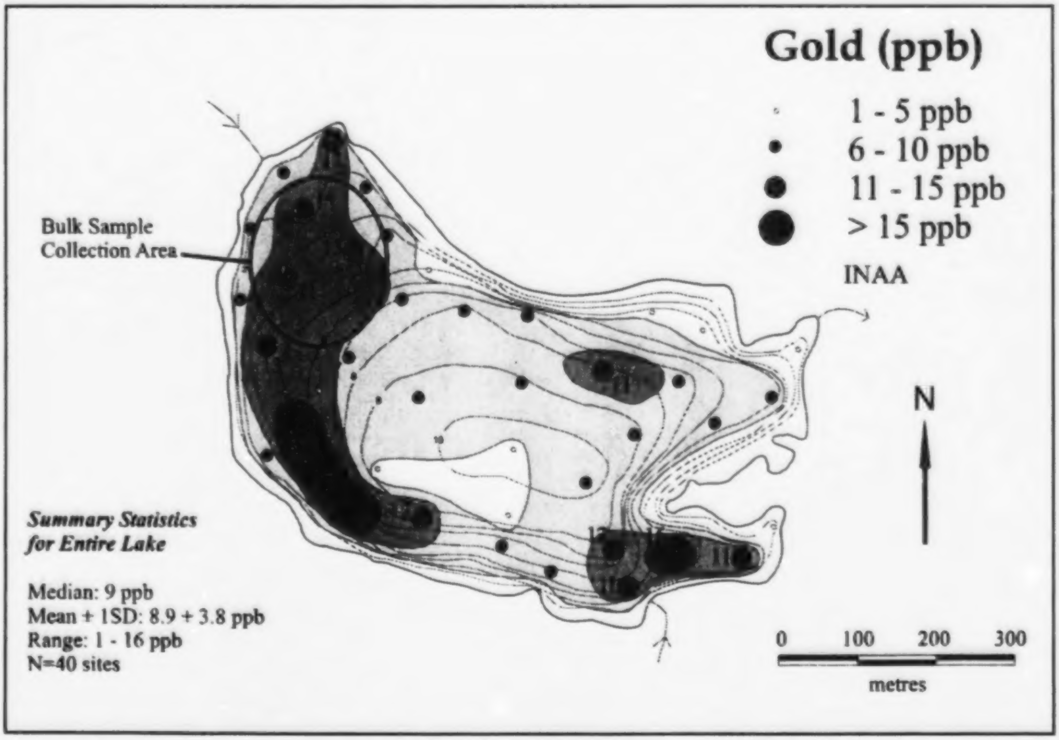

Figure 2. Distribution of gold (ppb) in sediments of Clisbako Lake, showing the location of 1997 bulk sediment sampling. Refer to Dawson (1991) and Schroeter and Lane (1992) for the local geological setting. Contours indicate sample depths, not bathymetry. Gold in sediments modified from Cook (1997b).

The Clisbako standard was inserted in several analytical suites of geochemical samples collected during the 1999 field season. A variety of analytical methods and/or digestions were used including thermal neutron activation analysis (INAA), atomic absorption spectroscopy (AAS), inductively-coupled plasma-emission spectroscopy (ICP-ES), inductively coupled plasma-mass spectrometry (ICP-MS), and major element oxide determination:

INAA suite: approximately 20 g sample splits were analyzed by thermal INAA for gold and 34 additional elements including arsenic, antimony and barium at Activation Laboratories Ltd., Ancaster, Ontario. These are 'total' determinations relative to the other methods employing acid digestions. Results for several elements including silver, mercury, irridium, nickel, tin and strontium are not reported here due to inadequate detection limits, low abundance and/or poor precision.

- AAS suite: samples were analyzed for 16 elements including zinc, copper, lead, silver, arsenic and antimony by AAS techniques following aqua regia digestion by CanTech Laboratories Ltd., Calgary. Fluorine was determined by specific ion electrode. Loss on ignition (LOI) at 550°C was also determined.
- ICP-ES suite: samples were analyzed for a suite of trace elements including molybdenum, copper and zinc by ICP-ES at Acme Analytical Laboratories Ltd., Vancouver, following aqua regia digestion.
- ICP-MS suite: one gram sample splits were analyzed for a suite of elements including molybdenum, copper, and antimony by ICP-MS and ICP-ES techniques at Acme Analytical Laboratories Ltd., Vancouver, following aqua regia digestion. Gold is also determined on the 1 g splits; depending on sample mineralogy, not all of the gold may be released by the acid digestion. LOI was determined in some cases.
- Major Element Oxides suite: determined by lithium metaborate ($LiBO_2$) fusion and an ICP-ES finish at Acme Analytical Laboratories Ltd., Vancouver. LOI, total carbon and total sulphur were also determined.

Further details of INAA and AAS analytical methods and/or digestion procedures are provided in standard regional lake sediment geochemistry open file reports such as Cook *et al.* (1997, 1998).

PRELIMINARY ANALYTICAL RESULTS

Statistical summaries of preliminary analytical results (INAA, AAS, ICP-ES, ICP-MS and major element oxide suites) for the Clisbako standard are given in Table 1. A more detailed account of INAA gold results is provided in Table 2. The purpose of these results is not to provide a comprehensive characterization of the Clisbako standard at this time, but rather to provide sufficient information for explorationists to obtain and prepare similar in-house control standards of their own.

Median INAA element concentrations of 13 ppb gold, 31 ppm arsenic and 3.9 ppm antimony were obtained (N=5 batches; n=19 samples). There are slight differences in summary statistical results here, which are based only on sediment from the western part of Clisbako Lake, relative to those reported for the entire lake by Cook (1995; 1997a,b). A mean gold concentration of 12.8 ± 3.2 ppb was obtained for all results. Application of a 10% trim to the data, and removal of two low (2 ppb) and high (17 ppb) sample outliers (Table 2), returned a trimmed mean gold concentration of 13.2 ± 1.8 ppb (n=17 samples; Figure 3). The relative standard deviation (RSD) for the trimmed sample is only 13.5%, versus 25.2% for all results.

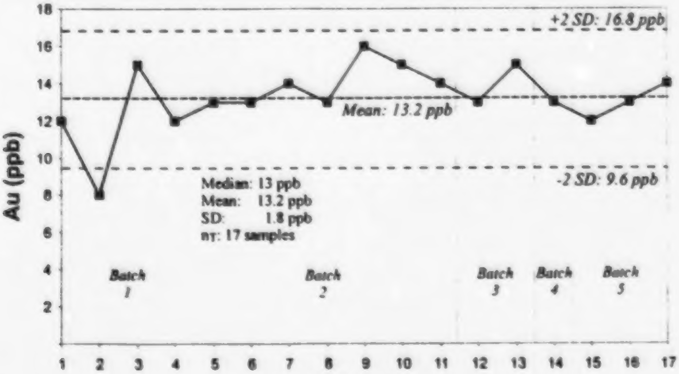

Figure 3. Standard control graph of gold (ppb) in the Clisbako lake sediment standard, showing trimmed data set results (n_T=17 samples) in relation to 2 standard deviations about the mean.

TABLE 1. SUMMARY STATISTICAL RESULTS FOR CLISBAKO LAKE SEDIMENT CONTROL STANDARD

Summary Statistics: INAA (N=5 batches)

	Au ppb	As ppm	Ba ppm	Br ppm	Co ppm	Cr ppm	Cs ppm	Fe %	Hf ppm	Rb ppm	Sb ppm	Sc ppm	Th ppm	U ppm	W ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Yb ppm	Lu ppm
Median	**13**	**31.0**	**220**	**127**	**10**	**70**	**4**	**2.26**	**2**	**18**	**3.9**	**6.3**	**2.3**	**4.3**	**1**	**11.4**	**19**	**11**	**2.7**	**0.7**	**1.5**	**0.25**
Mean	12.8	31.0	218.9	105.3	10.6	70.6	4.1	2.29	2.0	12.1	4.0	6.2	2.3	4.5	1.0	11.4	18.6	11.3	2.8	0.7	1.5	0.24
± 1 SD	3.2	2.5	30.7	44.1	0.8	3.4	0.3	0.14	0.0	14.6	0.3	0.3	0.2	0.5	0.0	0.5	1.4	2.0	0.2	0.1	0.1	0.02
%RSD	25.2	8.1	14.0	41.8	7.9	4.8	7.7	6.0	0.0	120.8	7.2	4.6	8.9	10.8	0.0	4.7	7.7	17.5	7.2	8.0	7.4	9.0

N=19

Summary Statistics: AAS (N=1 batch)

	Ag ppm	As ppm	Bi ppm	Cd ppm	Co ppm	Cu ppm	Fe %	F ppm	Hg ppb	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Sb ppm	V ppm	Zn ppm	LOI %
Median	**0.2**	**21.0**	**0.2**	**0.3**	**9**	**42**	**1.90**	**90**	**130**	**673**	**6**	**45**	**2**	**2.6**	**28**	**48**	**63.5**
Mean	0.2	19.7	0.2	0.3	8.7	42.0	1.87	90.0	130.0	672.7	5.0	45.3	2.0	2.7	28.3	47.3	63.7
± 1 SD	0.0	3.2	0.0	0.1	0.6	2.0	0.15	10.0	10.0	2.5	1.7	1.5	0.0	0.1	0.6	1.2	1.4
%RSD	0.0	16.3	0.0	21.7	6.7	4.8	8.2	11.1	7.7	0.4	34.6	3.4	0.0	4.3	2.0	2.4	2.1

N=3

Summary Statistics: ICP-ES (N=1 batch)

	Mo ppm	Cu ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	Sr ppm	Cd ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	B ppm	Al %	Na %	K %
Median	**4**	**44**	**46**	**0.5**	**55**	**8**	**645**	**1.99**	**22**	**127**	**0.3**	**35**	**1.47**	**0.06**	**10**	**44**	**0.40**	**70**	**9**	**0.82**	**0.03**	**0.05**
Mean	4.0	44.0	45.8	0.48	54.6	8.4	649.4	1.98	23.4	125.6	0.27	34.8	1.48	0.059	9.6	46.0	0.40	69.0	9.0	0.81	0.03	0.05
± 1 SD	0.0	1.9	1.1	0.15	2.1	0.5	26.9	0.10	3.4	4.0	0.06	1.8	0.05	0.002	0.5	7.6	0.02	2.0	3.6	0.03	0.01	0.01
%RSD	0.0	4.3	2.4	30.9	3.8	6.5	4.1	5.1	14.4	3.2	21.7	5.1	3.1	4.0	5.7	16.5	4.0	2.9	40.1	3.2	16.1	14.1

N=5

Summary Statistics: ICP-MS (N=2 batches)

	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppb	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppb	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %
Median	**4.89**	**45.4**	**3.66**	**47.4**	**273.5**	**55.4**	**9.9**	**656.0**	**1.97**	**31.1**	**4.2**	**11.5**	**1.0**	**128.9**	**0.21**	**3.78**	**0.08**	**38.5**	**1.39**
Mean	4.86	45.4	3.66	47.6	265.8	55.5	9.8	663.3	1.98	31.4	4.2	11.5	1.0	128.8	0.22	3.81	0.17	38.3	1.39
± 1 SD	0.22	0.9	0.63	0.5	34.4	1.0	0.5	25.3	0.03	1.6	0.1	1.3	0.1	2.1	0.05	0.19	0.20	2.1	0.05
%RSD	4.6	2.1	17.3	1.1	12.9	1.8	5.0	3.8	1.6	5.0	3.0	11.2	8.2	1.7	22.3	5.0	117.1	5.4	3.3

	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Tl ppm	Hg ppb	Se ppm	Te ppm	Ga ppm	S %	LOI* %
Median	**0.06**	**9.5**	**44.0**	**0.45**	**75.5**	**0.05**	**7.5**	**0.89**	**0.03**	**0.06**	**0.2**	**0.15**	**151.0**	**2.2**	**0.04**	**2.3**	**1.06**	**67.1**
Mean	0.06	9.5	45.7	0.45	75.9	0.05	7.3	0.89	0.03	0.06	0.2	0.15	152.3	2.2	0.04	2.3	1.06	67.1
± 1 SD	0.00	0.5	3.8	0.03	4.5	0.00	1.0	0.09	0.01	0.00	0.0	0.01	11.1	0.2	0.02	0.0	0.03	0.3
%RSD	4.2	5.0	8.4	7.7	5.9	5.8	13.2	10.1	17.4	0.0	0.0	8.9	7.3	8.3	40.8	0.0	3.1	0.4

N=4 (*N=2 for LOI)

Summary Statistics: Major Element Oxides (N=2 batches)

	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	MnO %	Cr_2O_3 %	Ba ppm	Ni ppm	Sr ppm	Zr ppm	Y ppm	Nb ppm	Sc ppm	LOI %	C/Tot %	S/Tot %	Sum %
Median	**21.54**	**4.14**	**3.14**	**0.81**	**2.22**	**0.51**	**0.52**	**0.26**	**0.16**	**0.08**	**0.012**	**179**	**53**	**177**	**70**	**13**	**10**	**4**	**66.6**	**32.34**	**1.18**	**99.95**
Mean	21.46	4.20	3.14	0.82	2.25	0.50	0.47	0.26	0.15	0.08	0.013	179.3	53.7	175.9	72.9	12.9	10.0	4.1	66.54	32.73	1.18	99.93
± 1 SD	0.49	0.13	0.11	0.02	0.07	0.03	0.10	0.01	0.04	0.00	0.002	5.3	5.3	5.5	13.1	1.2	0.0	0.7	0.18	1.09	0.02	0.07
%RSD	2.3	3.0	3.5	2.5	3.0	5.2	22.1	4.8	24.5	5.9	15.8	2.9	9.8	3.1	17.9	9.4	0.0	16.7	0.3	3.3	1.7	0.1

N=7

TABLE 2. CLISBAKO CONTROL STANDARD: PRELIMINARY AU (INAA) RESULTS

A) All Data		B) 2 Outliers Removed	
Sample	Au ppb	Sample	Au ppb
986064	12	986064	12
986148	8	986148	8
986230	15	986230	15
986355	12	986355	12
986384	2		
991026	13	991026	13
991065	13	991065	13
991118	14	991118	14
991147	13	991147	13
991158	16	991158	16
991159	15	991159	15
991160	14	991160	14
996541	13	996541	13
996542	15	996542	15
995011	17		
995105	13	995105	13
996052	12	996052	12
996053	13	996053	13
996054	14	996054	14
Median	13	**Median**	13
Mean	12.8	**Mean**	13.2
SD	3.2	**SD**	1.8
% RSD	25.2	**% RSD**	13.5
Minimum	2.0	**Minimum**	8.0
Maximum	17.0	**Maximum**	16.0
n	19	**n_T**	17

Interestingly, mean ICP-MS gold results (11.5 ± 1.3 ppb) compare favourably on both magnitude and reproducibility with those determined by INAA, although these are based on only four determinations on small sample splits. This can likely be attributed to the very fine-grained nature of both the primary epithermal mineralogy and of the lake sediment itself. No fire assay gold determinations have yet been made on the standard for further comparison with INAA and ICP-MS gold results. Analysis will continue as the Clisbako standard is inserted in future lake sediment and other analytical suites; additional results of further round-robin tests at various laboratories will be reported at a later date.

SUMMARY

Preliminary analytical results for a bulk lake sediment sample taken from the west end of Clisbako Lake indicate median INAA element concentrations of 13 ppb gold, 31 ppm arsenic and 3.9 ppm antimony. The magnitude and reproducibility of the gold results, and the elevated levels of arsenic and antimony present, suggest this material to be suitable for use as a low-concentration gold control standard for geochemical exploration for epithermal gold deposits.

There are limitations to its potential use in geochemical surveys and other studies. Adularia-sericite type epithermal gold deposits such as Clisbako are characterized by extremely fine-grained mineralization relative to other gold deposit types. Consequently, other more appropriate standard materials might be more suited for lake sediment geochemical exploration for different, more coarse-grained, varieties of gold deposits. Similarly, the organic-rich nature of Clisbako lake sediment precludes its effective use in analytical suites containing other types of geochemical sample media such as stream sediments, soil, till or rock. Clisbako analytical results would not be completely representative of these materials, which have very different sample matrices with respect to texture and organic matter content.

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RESULTS OF GEOCHEMICAL FOLLOW-UP INVESTIGATIONS AT THREE ANOMALOUS RGS STREAM SEDIMENT LOCALITIES IN CENTRAL BRITISH COLUMBIA (93L/16; 93N/4)

By Stephen J. Cook

INTRODUCTION

The purpose of this paper is to describe results of follow-up geochemical studies at three Regional Geochemical Survey (RGS) sites in central British Columbia. The RGS program contains multi-element geochemical data for over 42,000 stream sediment and water sites covering approximately 65% of the province. There is complete regional geochemical coverage for the Smithers (NTS 93L), Hazelton (NTS 93M) and Manson River (NTS 93N) map areas, where bedrock mapping projects in the Babine Porphyry Belt (MacIntyre *et al.*,1996, 1997; MacIntyre, 1998) and the Sitlika Assemblage (Schiarizza *et al.*, 1998, 2000) have recently been completed under the auspices of the Nechako NATMAP Project. These, and complementary surficial mapping and till and lake sediment geochemical studies are conducted, in part, to determine the potential for further mineral deposit discoveries in the region. Two important deposit types here are porphyry-style copper deposits in the Babine Belt, and volcanogenic massive sulphide (VMS) deposits in the Pennsylvanian-Jurassic Cache Creek Group and the Permo-Triassic Sitlika Assemblage. Porphyry copper deposits such as the past-producing Bell (MINFILE 93M 001) and Granisle (MINFILE 93L 146) mines are the most important mineral deposit type in the Babine porphyry belt. Most are associated with Eocene-age Babine Intrusions (50.2-55.8 Ma), which are exposed in a north-trending belt extending from Fulton Lake in the south to Trail Peak in the north (MacIntyre *et al.*, 1997). Other porphyry-style prospects, including those at Hearne Hill (MINFILE 93M 006), Morrison (MINFILE 93M 007), Nak (MINFILE 93M 010) and Trail Peak (MINFILE 93M 011), remain the primary exploration targets in the region. In the Manson River area, correlation of the Permo-Triassic Sitlika Assemblage with Permo-Triassic Kutcho Formation rocks in the King Salmon Assemblage of northern B.C. (Schiarizza *et al.*, 1998; Childe and Schiarizza, 1997) has highlighted the potential of this part of central British Columbia for hosting polymetallic VMS deposits. The Kutcho Formation, a bimodal mafic-felsic volcanic package with subordinate sedimentary rocks, hosts the 17 Mt Kutcho Creek Cu-Zn volcanogenic massive sulphide deposit (Barrett *et al.*, 1996).

There are numerous RGS stream sediment sites with elevated geochemical signatures in the Smithers (Johnson *et al.*, 1987), Hazelton (Jackaman, 1998a) and Manson River (Jackaman, 1998b) map areas which might reflect the presence of buried VMS or porphyry-style mineralization. To this end, anomalous watersheds at three locations in the Babine and Takla lakes area (Figure 1) were investigated and re-sampled in an attempt to verify the original RGS anomalies and identify any possible sources. Similar projects were previously undertaken in southern British Columbia (Cook *et al.*, 1992) and northern Vancouver Island (Sibbick and Laurus, 1995). This paper, a contribution to the Nechako NATMAP Project, provides a brief outline of the case study geochemical results. They are not exhaustive; the intent here is to highlight the reproducibility of anomalous stream sediment metal values and to bring attention to prospective areas which may have been previously overlooked.

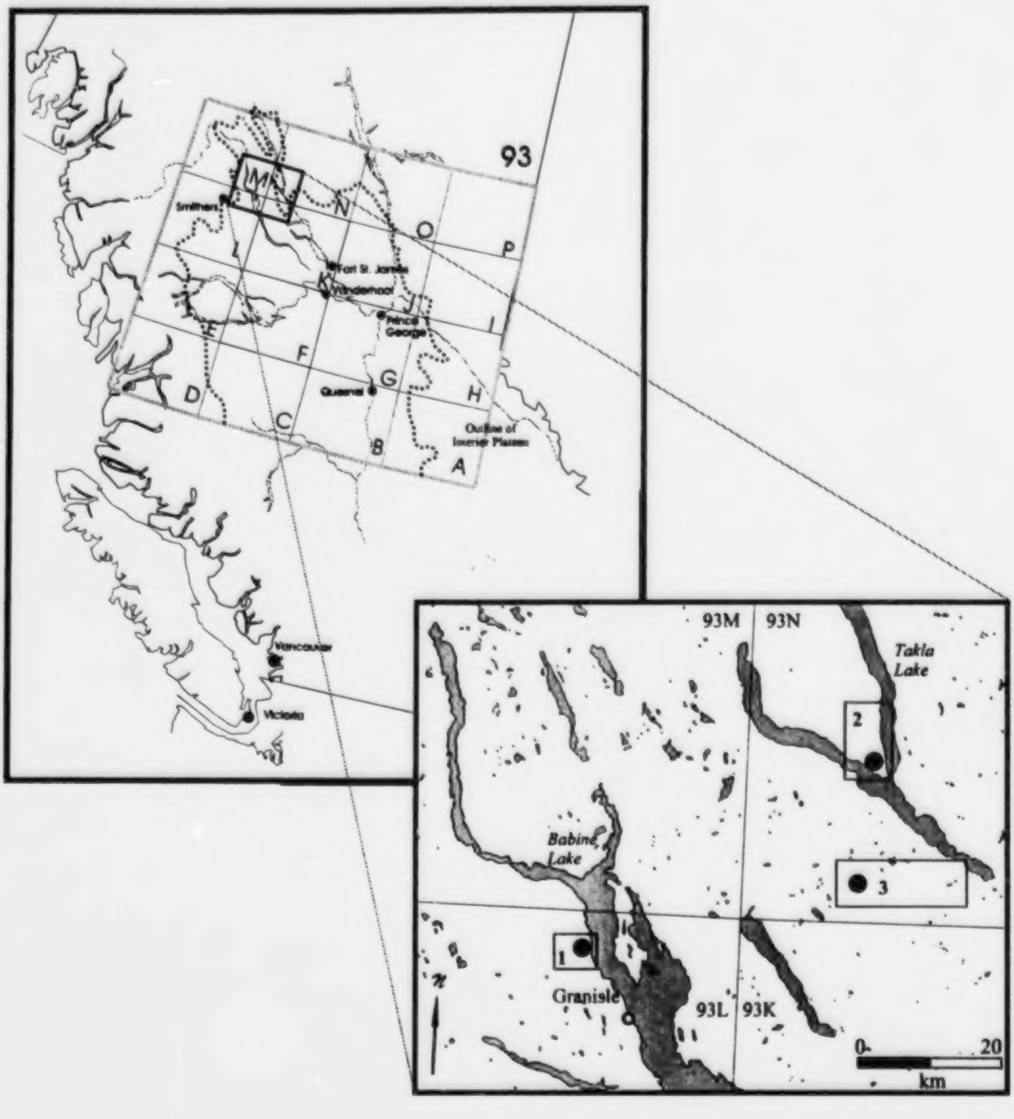
SELECTION OF ANOMALOUS SITES

Follow-up investigations were conducted in three areas (Figure 1) during the 1996 and 1997 field seasons:

- unnamed creeks, Granisle area (NTS 93L/16) Area 1
- unnamed creeks, Takla Lake area (NTS 93N/4) Area 2
- Bivouac Creek, Takla Lake area (NTS 93N/4) Area 3

The first follow-up area, in the Babine porphyry belt, was selected for study because of the very high RGS sediment copper concentration (1170 ppm) at one site. This site (861109) has the highest copper concentration of 849 sites in the Smithers (NTS 93L) map area (Johnson *et al.*, 1987). There are no known mineral prospects in the vicinity of the watershed, which was unstaked at the time of sampling.

Element sum ranking of RGS data characteristic of volcanogenic massive sulphide (VMS) deposits was used to select the two follow-up areas in the Manson River map area, where Cache Creek Group and Sitlika


93
M
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H
D
C
B
A
Smithers
Fort St. James
Vanderhoof
Prince George
Quesnel
Outline of Interior Plateau
Vancouver
Victoria
93M
93N
Takla Lake
2
Babine Lake
3
1
Granisle
93L
93K
0
20
km

Figure 1. Location map of three RGS follow-up study areas in the Smithers (NTS 93L) and Manson River (NTS 93N) map areas, central British Columbia.

Assemblage rocks may be host to such deposits. This technique was used to identify RGS stream sediment sites with elevated combined copper-zinc-lead-silver signatures. Briefly, the method used is as follows: zinc, copper, lead and silver data for RGS sites in the western half of the Manson River map area (Jackaman, 1998b) were summed using the algorithm $Zn + Cu + (10*Pb) + (100*Ag)$. Lead and silver results were multiplied by factors of 10 and 100, respectively, to bring all four elements to equivalent orders of magnitude, as based on regional median concentrations. The resulting site scores (N=550 sites) were ranked and plotted, and two groups of RGS watersheds within the top five percentiles of combined data rankings were selected for further investigation. Neither of the two areas, both of which are in the Takla Lake area, are known to contain any mineral deposits. One unnamed creek (RGS site 831893) drains into the Northwest Arm of Takla Lake just west of Takla Narrows; the second creek (RGS site 831904) and adjoining sites are located about 14 km to the south in the western headwaters of Bivouac Creek. This method was also used to select RGS stream sediment sites for further investigation in Yukon-Tanana Terrane correlative rocks of the Big Salmon Complex in northern British Columbia (Cook and Pass, 2000).

New instrumental neutron activation (INAA) analytical data for gold, precious metal pathfinders and rare earth elements for 2097 stream sediment and water sites in the Hazelton and Manson River map areas were released in 1998 (Jackaman, 1998a,b). Stream sediment samples were collected here in 1984, with initial release of trace element data for copper, zinc, nickel and other elements happening the following year.

Another interpretative technique which may be used to rate and identify RGS sites characterized by multi-element geochemical signatures is briefly outlined here for interested readers. No multi-element anomaly rankings are available for older surveys (*e.g.* Smithers area; Johnson *et al.*, 1987), but results for anomalous sites in the Manson River area are reported by Jackaman (1998b) and reproduced in Table 4 for each follow-up site. The method consists of calculating 90th, 95th and 98th percentile thresholds for each metal in each geological unit containing ten or more sample sites, and then assigning anomaly ratings to individual samples exceeding these thresholds. Those samples at or exceeding the 98th percentile for any given geological unit are assigned an anomaly rating of 3. Those samples having concentrations between the 95th and 98th percentiles for a geological unit are assigned an anomaly rating of 2, while those between the 90th and 95th percentiles are assigned a rating of 1. Element ratings for base metal associations (Cu-Pb-Zn-Ag-Ba) and precious metal associations (Au-Sb-As-Ag-Hg) are summed for each site, with the highest rankings in the Manson River area assigned to those sites with a top rating of at least 7 in either group. Complete details of the method are given in RGS data booklets (*e.g.* Jackaman, 1998a,b).

FOLLOW-UP OF ANOMALOUS SITES

FIELD SAMPLING METHODS

Three streams in the Granisle area were sampled during June-August 1996, with a fourth stream later located and sampled in August 1999. All Takla Lake-area streams were sampled in August 1997. The original RGS site was re-sampled in each drainage, but the extent of further follow-up sampling varied in each case. In most cases adjacent streams, some of which were not part of the original RGS surveys, were also sampled. Additional samples were also obtained from upstream sites in most cases, particularly in the Granisle area where one stream was selected for detailed sampling to further investigate within-stream geochemical variation. Stream sediments and/or moss mats, depending on availability, were collected at most sites to evaluate comparative geochemical responses of the two media. Water geochemical data was also obtained to compare geochemical responses of the dissolved fraction with that of the sediment. Two paired water samples were obtained at most sites using 250 ml high-density polyethylene (HDPE) bottles: a raw unfiltered water sample similar to that routinely collected during RGS surveys, and a second sample for major element and trace element analysis, and for determination of conductivity and total dissolved solids (TDS). In a few cases no sediment sample could be obtained, and only a water sample was collected. A small number of rock samples occurring as stream bed float were collected and analyzed for trace and precious elements.

SAMPLE PREPARATION AND ANALYTICAL METHODS

A brief description of sample preparation and analytical methods is given below. Complete details of standard sediment and water analytical procedures are provided in recent RGS reports (*e.g.* Jackaman, 1998a,b), and by Cook *et al.* (1999), respectively.

Preparation of sediment and moss mat samples was conducted at Rossbacher Laboratory, Burnaby, using standard RGS procedures. Stream sediments were air-dried and dry sieved to -80 mesh (<177 microns) using stainless steel sieves. In preparation of moss mats (*e.g.* Gravel and Matysek, 1989), fine sediment is disaggregated from the moss fronds by gentle pounding and passed through a 20 mesh (<850 micron) sieve prior to sieving to -80 mesh (<177 microns). Two splits of each sample were taken for submission to analytical laboratories. One split was submitted to CanTech Laboratories Inc., Calgary, Alberta for analysis of 16 elements (zinc, copper, lead, silver, molybdenum, cobalt, mercury, iron, manganese, nickel, fluorine, cadmium, vanadium, bismuth, antimony and arsenic) by atomic absorption spectroscopy (AAS) following aqua regia digestion. Loss on ignition (LOI) was also determined. Selenium and tellurium were also determined on Takla Lake and Bivouac Creek-area samples. A second, approximately 30 gram, split of each sample was submitted to Activation Laboratories, Ancaster, Ontario, for analysis of gold and 34 additional elements using thermal instrumental neutron activation analysis (INAA).

Data for 25 elements (gold, antimony, arsenic, barium, bromine, calcium, cerium, cesium, chromium, cobalt, europium, hafnium, iron, lanthanum, lutetium, neodymium, rubidium, samarium, scandium, sodium, thorium, tungsten, uranium, ytterbium and zinc) are reported here (Table 5). Additional data for several other elements (silver, mercury, irridium, nickel, tin, selenium and strontium) are not reported due to inadequate detection limits, low element abundance and/or poor precision.

Unfiltered stream waters were analyzed for the standard RGS water analytical suite (uranium, fluoride, sulphate, pH) at CanTech Laboratories, Inc., Calgary. In the case of the second water sample obtained for major and trace element analysis, an approximately 125 ml aliquot was filtered to 0.45 microns using Sartorius 47 mm filters and a Nalgene filtration apparatus with hand pump. Filtered waters were then transferred to 250 ml I-Chem Certified high-density polyethylene (HPDE) acid-washed bottles, acidified to approximately ph=2 with Merck Suprapure concentrated nitric acid, and submitted to Activation Laboratories, Ancaster, Ontario for analysis of 66 elements using a Perkin Elmer Elan 6000 inductively coupled plasma-mass spectrometer (ICP-MS) and a Perkin Elmer AS91 autosampler. These elements, most of which are reported here (Table 6), include 7 major elements (aluminum, calcium, iron, magnesium, potassium, silicon and sodium) and trace elements such as copper, zinc, molybdenum, arsenic, antimony and nickel. The remaining 125 ml aliquot of unfiltered water was retained for field determination of conductivity and total dissolved solids (TDS) using a Corning Checkmate 90 conductivity/TDS meter. Total alkalinity (T-Alk) was determined on Takla Lake and Bivouac Creek-area samples using a Lamotte alkalinity test kit.

Rock samples were prepared in the Analytical Sciences Laboratory, Victoria using a steel ring mill, and submitted to Acme Analytical Laboratories Ltd., Vancouver, for trace element determination by inductively coupled plasma-atomic emission spectroscopy (ICP-AES) following aqua regia digestion. A second sample split was submitted to Activation Laboratories, Ancaster, for INAA determination of gold and additional elements. Several rock samples with highly elevated concentrations of copper, lead, nickel and other elements were subsequently re-analyzed by ICP-AES following nitric-aqua regia digestion at Chemex Labs, North Vancouver.

Field and analytical duplicates were included in the analytical suites, together with appropriate ranges of copper and zinc-bearing control reference standards. Field duplicate sediment results are reported in Table 5 where they are denoted as 'Rep 20' samples. Analytical duplicate results for two pairs of Manson River-area sediment and moss mat samples (Table 1) indicate an acceptable level of analytical precision. Selected results for CANMET certified reference materials STSD-1 and STSD-4, and for two internal GSB standards (Table 2), similarly indicate acceptable analytical accuracy for copper, zinc and other elements. Results for two water standards, National Research Council (NRC) water reference material SLRS-3 and an internal GSB water standard, are shown in Table 3. Certified values for CANMET and NRC sediment and water standards are from Lynch (1990) and NRC (1994), respectively.

TABLE 1. ANALYTICAL DUPLICATE RESULTS FOR AAS AND SELECTED INAA DETERMINATIONS

			972002	972001	972103	972101
			Sediment		Moss mat	
	Element		*Original Sample*	*Analytical Duplicate*	*Original Sample*	*Analytical Duplicate*
AAS	Ag	*ppm*	<0.2	0.2	0.2	<0.2
	As	*ppm*	9.3	8.2	4.2	4.0
	Bi	*ppm*	0.3	0.5	0.1	0.1
	Cd	*ppm*	1.6	1.5	2.2	2.0
	Cu	*ppm*	49	50	33	32
	Co	*ppm*	19	20	9	10
	Fe	%	2.9	2.8	2.5	2.4
	F	*ppm*	180	180	260	140
	Hg	*ppb*	40	40	70	70
	Mn	*ppm*	502	485	456	447
	Mo	*ppm*	5	7	5	3
	Ni	*ppm*	146	148	33	33
	Pb	*ppm*	6	7	9	7
	Sb	*ppm*	2.8	2.1	1.0	1.0
	V	*ppm*	52	51	47	45
	Zn	*ppm*	234	237	235	232
	Se	*ppm*	1.7	1.8	0.9	0.9
	Te	*ppm*	0.1	0.1	0.1	0.1
	LOI	*ppm*	7.3	6.1	12.7	11.5
INA	Au	*ppb*	5	3	18	5
	As	*ppm*	11	9.9	5.2	5.2
	Ba	*ppm*	530	570	480	450
	Ce	*ppm*	22	20	21	21
	Cr	*ppm*	250	260	61	64
	Fe	%	3.21	3.18	2.29	2.38
	Sb	*ppm*	1.7	1.6	0.9	0.9

TABLE 2. SELECTED CONTROL STANDARDS RESULTS: STREAM SEDIMENTS

Granisle Suite *(n=1 each)*	Cu (ppm)	Zn (ppm)	Mo (ppm)	Sb (ppm)	Au (INA) (ppb)
STSD-1	34 *(36 ± 2)*	163 *(165 ± 8)*	2 *(2 ± 0.5)*	2.5 *(2.0 ± 1.0)*	20 *(8 ± 4)*
STSD-4	66 *(66 ± 5)*	80 *(82 ± 8)*	2 *(2 ± 0.6)*	6.9 *(3.6 ± 2.5)*	<2 *(4 ± 2)*
Std. 'X'	146 *(158-171)*	47 *(48-49)*	14 *(13-14)*	0.4 *(0.3-0.4)*	49 *(41-52)*

Takla L. Suite *(n=1 each)*	Cu (ppm)	Zn (ppm)	Pb (ppm)	Sb (ppm)	Au (INA) (ppb)
Std. 'X'	157 *(158-171)*	48 *(48-49)*	5 *(5-6)*	0.3 *(0.3-0.4)*	28 *(41-42)*
Std. 'Y'	41 *(41-44)*	98 *(84-102)*	17 *(15-16)*	2.1 *(1.1-1.4)*	11 *(11-14)*

Certified Reference Materials: (Mean ± 1s) in brackets from Lynch (1990
Internal GSB standards: (accepted range) in brackets

RESULTS AND INTERPRETATION

Selected RGS geochemical data for the three areas are shown in Table 4. Those results within the top five percentiles of regional data are denoted by bold type, and results of RGS base or precious metal rankings of Jackaman (1988b) reported. For purposes of comparison, various RGS percentile threshold concentrations for selected elements are given for the Smithers and Manson River map areas. Stream sediment and moss mat data from follow-up sites are given in Table 5, and corresponding stream water data in Table 6. Rock geochemical data for miscellaneous stream bed float samples are shown in Table 7.

AREA 1: GRANISLE (NTS 93L/16)

Location, Geology and Regional Geochemistry

The anomalous RGS site (93L/16 861109) is located on an unnamed creek on the west side of Babine Lake, about 10 km northwest of Granisle village (Figure 2). The past-producing Granisle and Bell copper mines are located several kilometres to the east and northeast on Babine Lake, on McDonald-Sterrett Island and the Newman Peninsula, respectively. The reported sediment copper concentration (1170 ppm) at this RGS site is the highest in the Smithers map area, and elevated gold values (45 ppb) are also present (Table 4). Two adjacent creeks, one immediately to the south (861110) and the second about 2 km southward (861106), also contain elevated RGS copper concentrations of 66 ppm and 56 ppm, respectively (Figure 2). Both results exceed the 90th percentile of RGS copper data in the Smithers map area (48 ppm). All three streams flow eastward to Babine lake and were re-sampled upstream of the Bell barge road in 1996. However, the UTM locations of sites 861109 and 861110 are not on the mapped streams in this area, suggesting that the sites may have been incorrectly plotted at the time of the survey.

The thickly-vegetated stream watersheds are underlain primarily by volcanic and sedimentary rocks of the Upper Triassic Takla Group (Figure 2). Eocene-age Newman volcanics are exposed at the upper reaches of the watersheds. A GSB regional lake sediment site located a few kilometres southwest of the upper limits of the watersheds also reported elevated (>95th percentile of Babine porphyry belt sites) concentrations of copper (76 ppm), mercury (430 ppb) and cadmium (1.8 ppm), among other elements (Cook *et al.*, 1998; in press).

Results

Resampling of what was initially considered to be the original RGS site (Stream 1), 5.8 km north of the intersection of the Bell barge road with the Granisle-Smithers road, failed to confirm anomalous results of 1170 ppm Cu and 45 ppb gold. Only moderately elevated concentrations of 54 ppm copper (Figure 3) and 7 ppb gold occur in Stream 1, in spite of the discovery of a small chalcopyrite-bearing boulder in the stream bed. Copper concentrations increase slightly upstream, with 73 ppm copper and 11 ppb gold present at the most distant site sampled some 600 metres from the Bell barge road. Also, a single till sample collected from a slump on the south side of the stream bank here returned an elevated copper value of 76 ppm. Copper concentrations are marginally lower in the tributary Stream 2, in the range 47-53 ppm, and at only background levels (31-35 ppm) in Stream 3 to the south. Furthermore, concentrations of other elements in sediments of the three streams do not differ appreciably from background levels (Table 4), with the exception of cobalt in stream 1. Cobalt (AAS) concentrations up to 18 ppm (Table 5) are in the top five percentiles of regional data for the Smithers map area.

A return to the Granisle area in 1999 to further investigate this inconsistency with the original RGS results resulted in the finding of another very small intermittent creek (Stream 4; Figure 3) on the Bell barge road approximately 600-700 metres north of Stream 1. The narrow creek is obscured by heavy underbrush, and was only located by walking north along the roadside from Stream 1. Sediment geochemical results here (Table 5) returned detectable gold levels (7 ppb) and the highest follow-up copper concentration (88 ppm) in the area.

TABLE 3. SELECTED CONTROL STANDARDS RESULTS: STREAM WATERS

			1996 96SCW25 SLRS-3	1997 974010 SLRS-3	1997 974204 SLRS-3	*SLRS-3* *Certified* *Values*	974109 CH-1	974316 CH-1
ICP-MS	Na	*ppb*	2279.1	2563	2490	*2300 ± 200*	3137	3043
	Mg	*ppb*	1629.6	1671	1661	*1600 ± 200*	3321	3351
	Al	*ppb*	31.2	33	31	*31 ± 3*	5	5
	Si	*ppb*	1707	1698	1634	-	4598	4746
	K	*ppb*	697	681	666	*700 ± 100*	2303	2182
	Ca	*ppb*	6040	5797	5659	*6000 ± 400*	11350	10873
	Ti	*ppb*	0.43	0.4	0.5	-	0.9	0.9
	V	*ppb*	0.35	0.24	0.28	*0.30 ± 0.02*	0.24	0.27
	Mn	*ppb*	3.82	3.86	4.20	*3.9 ± 0.3*	0.06	0.12
	Fe	*ppb*	99.3	94	99	*100 ± 2*	3	3
	Co	*ppb*	0.023	0.032	0.035	*0.027 ± 0.003*	0.014	0.015
	Ni	*ppb*	0.720	0.74	0.56	*0.83 ± 0.08*	<0.05	<0.05
	Cu	*ppb*	1.456	0.9	0.9	*1.35 ± 0.07*	1.4	1.4
	Zn	*ppb*	1.335	1.2	1.3	*1.04 ± 0.09*	1.4	1.4
	As	*ppb*	0.72	0.74	0.75	*0.72 ± 0.05*	0.12	0.11
	Br	*ppb*	26	30	30	-	6	6
	Rb	*ppb*	1.762	1.704	1.669	-	2.931	2.964
	Sr	*ppb*	31.265	30.9	30.3	*28.1*	36.8	37.6
	Y	*ppb*	0.130	0.124	0.120	-	0.017	0.018
	Zr	*ppb*	0.267	0.103	0.081	-	0.024	0.032
	Mo	*ppb*	0.23	0.22	0.21	*0.19 ± 0.01*	0.06	0.06
	Sb	*ppb*	0.15	0.158	0.168	*0.12 ± 0.01*	0.036	0.039
	Ba	*ppb*	13.197	13.8	13.6	*13.4 ± 0.6*	3.07	3.18
	Ce	*ppb*	0.279	0.271	0.282	-	<0.005	0.007
	Nd	*ppb*	0.227	0.196	0.193	-	0.004	0.005
	U	*ppb*	0.040	0.041	0.033	*0.045*	<0.001	<0.001
Other Methods	U	*ppb*	-	-	-	-	<0.05	<0.05
	F	*ppb*	-	-	-	-	110	110
	SO4	*ppm*	-	-	-	-	25	29
	pH		-	-	-	-	7.5	7.3

Certified Reference Material SLRS-3: Mean ± 1s (NRC, 1994)

These results are considerably lower than reported for RGS site 861109. However, evidence from several disparate field variables recorded during the 1986 RGS survey (width, depth, flow rate, drainage pattern, stream type) suggest that narrow, shallow and intermittent Stream 4 may represent anomalous RGS site 861109, whereas wider, deeper, permanent and continuous Stream 1 may in fact represent the adjacent lower-copper site 861110 to the south. Furthermore, slight variations in the geochemical abundance of several other elements at RGS site 861109, such as fluorine, lead and antimony in sediment and fluoride in water (Table 4; Johnson *et al.*, 1987), more closely resemble that of follow-up Stream 4 than of Stream 1. It is noteworthy that the two stream UTM latitude coordinates vary from those of RGS sites 861109 and 861110 of Johnson *et al.* (1987) by almost exactly 1000 metres, suggesting that both sites might have been incorrectly plotted southward along the Bell barge road by a single digit.

TABLE 4. SELECTED RGS DATA FOR FOLLOW-UP SITE LOCALITIES

Follow-up Area	Map	ID	Geology	Cu *(ppm)*	Pb *(ppm)*	Zn *(ppm)*	Ag *(ppm)*	Ba *(ppm)*	Mo *(ppm)*	Co *(ppm)*	Au *(ppb)*	Sb *(ppm)*	As *(ppm)*	Hg *(ppb)*	LOI *(%)*	Anomalous Elements *(>95th pctile)*	RGS Base Metal Ranking (max: 20)	RGS Precious Metal Ranking (max: 20)	Reference
1 Granisle area	93L/16	861106	VCCB[1]	56	9	82	0.1	571	1	10	4	0.2	5	55	6.2	-	*NA*	*NA*	Johnson *et al*. (1987)
		861109	VCCB[1]	**1170**	12	79	0.1	602	**5**	12	**45 (40)**	0.7	5	75	7.8	Cu-Mo-Au	*NA*	*NA*	
		861110	VCCB[1]	**66**	11	81	0.2	551	1	12	2	0.4	5	55	8.2	Cu	*NA*	*NA*	
2 Takla lake area	93N/4	831893	uTrSv*[1]	53	7	**205**	0.3	1200	4	**25**	11	**2.2**	14.5	40	-	Zn-Sb-Co-Ni	4 (Zn-Ba)	6 (Sb-As)	Jackaman (1998b)
		831922	uTrSv*[2]	42	4	72	0.2	950	2	15	5	0.4	10	50	-	-	-	-	
3 Bivouac Creek	93N/4	831900	PTrCCs[2]	28	3	85	0.4	880	1	10	5	0.1	5.5	60	-	-			Jackaman (1998b)
		831902	PTrCCs[1]	32	5	**235**	0.3	930	2	9	10	0.4	6.0	110	-	Zn	3 (Zn)	-	
		831904	PTrCCs[2]	100	7	**153**	**1.1**	550	3	7	8	**2.2**	8.5	220	-	Zn-Ag-Sb	9 (Cu-Zn-Ag)	11 (Ag-Sb-Hg-As)	
		831906	PTrCCs[2]	88	6	113	0.5	690	2	10	7	0.1	7.0	160	-	-	4 (Cu-Zn)	3 (Hg)	
Percentile Rankings by Survey																			
Smithers	93L		50th	24	9	84	0.1	736	1	10	1	0.5	5	40	4.6				Johnson *et al*. (1987)
RGS 17			90th	48	16	139	0.3	1050	1	15	10	1.8	13	80	9.8				
(N=849 sites)			95th	59	22	175	0.4	1230	1	16	25	2.6	19	100	12.6				
			98th	80	33	280	0.5	1400	3	20	60	3.5	35	140	15.4				
			Max	1170	532	825	3.7	2900	69	45	5400	27.5	98	795	57.6				
Manson River	93N		50th	36	3	50	0.2	1100	1	10	8	0.3	3	60	-				Jackaman (1998b)
RGS 49			90th	80	6	91	0.4	1700	3	18	28	0.9	10	160	-				
(N=1029 sites**)			95th	104	10	113	0.5	1900	5	22	53	1.4	16	230	-				
			98th	135	15	196	0.7	2500	8	31	120	2.1	29.5	420	-				
			Max	490	437	1200	3.2	7990	53	79	760	23.0	285	99999	-				

NA: ranking not available for sites in NTS 93L
* most widespread of two or more geological units
** for most AAS elements; 988 sites for Au and Ba

1986 Au data by Fire Assay (FA); other data by INAA
Repeat Au analysis shown in brackets
1986 Ba data by AAS; other data by INAA

[1] MacIntyre *et al.* (1994)
[2] Bellefontaine *et al.* (1995)
Sites >95th percentile are denoted by bold type

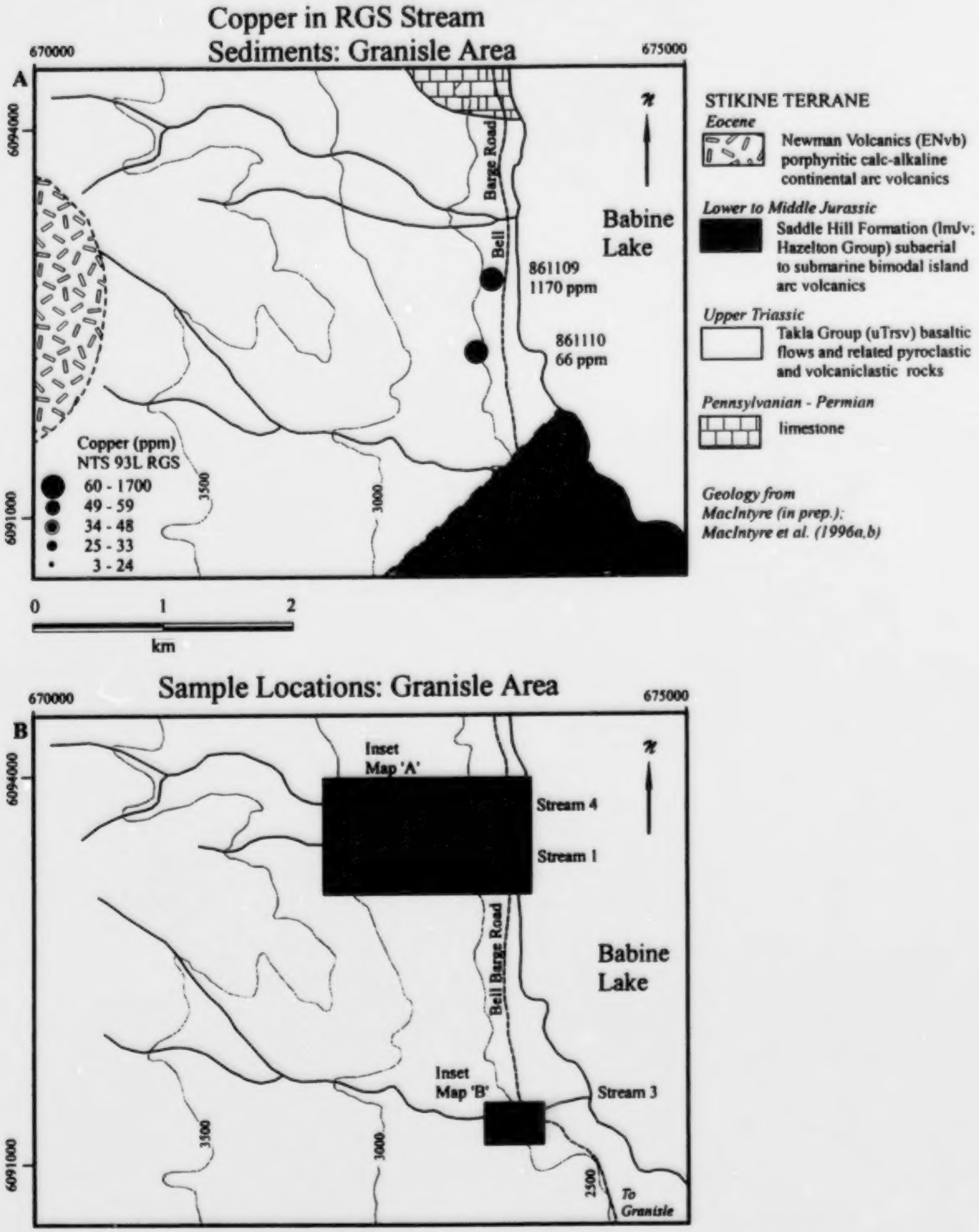
Copper in RGS Stream Sediments: Granisle Area
670000
675000
A
6094000
6091000
Barge Road
Bell
Babine Lake
861109
1170 ppm
861110
66 ppm
Copper (ppm)
NTS 93L RGS
60 - 1700
49 - 59
34 - 48
25 - 33
3 - 24
3500
3000
0
1
2
km
STIKINE TERRANE
Eocene
Newman Volcanics (ENvb) porphyritic calc-alkaline continental arc volcanics
Lower to Middle Jurassic
Saddle Hill Formation (lmJv; Hazelton Group) subaerial to submarine bimodal island arc volcanics
Upper Triassic
Takla Group (uTrsv) basaltic flows and related pyroclastic and volcaniclastic rocks
Pennsylvanian - Permian
limestone
Geology from MacIntyre (in prep.); MacIntyre et al. (1996a,b)
Sample Locations: Granisle Area
670000
675000
B
6094000
6091000
Inset Map 'A'
Stream 4
Stream 1
Bell Barge Road
Babine Lake
Inset Map 'B'
Stream 3
3500
3000
2500
To Granisle

Figure 2. Granisle study area: a) geological setting and RGS stream sediment copper results, and b) location of follow-up areas. See text for further comments on RGS site locations.

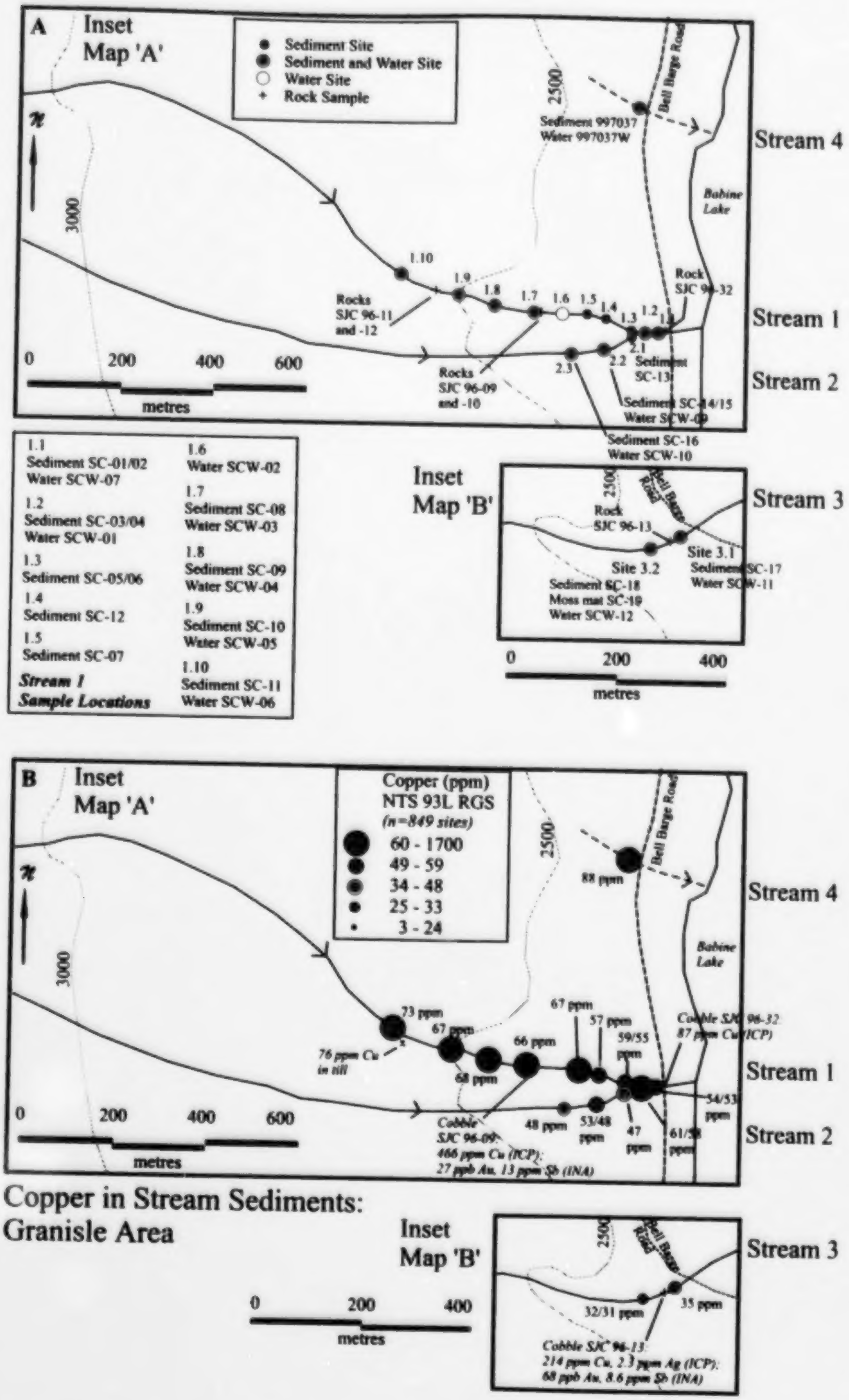
A
Inset Map 'A'
Sediment Site
Sediment and Water Site
Water Site
Rock Sample
2500
3000
Bell Barge Road
Sediment 997037
Water 997037W
Stream 4
Babine Lake
1.10
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
2.1
2.2
2.3
Rock SJC 96-32
Rocks SJC 96-11 and -12
Rocks SJC 96-09 and -10
Sediment SC-13
Sediment SC-14/15 Water SCW-09
Sediment SC-16 Water SCW-10
Stream 1
Stream 2
0 200 400 600
metres
1.1 Sediment SC-01/02 Water SCW-07
1.2 Sediment SC-03/04 Water SCW-01
1.3 Sediment SC-05/06
1.4 Sediment SC-12
1.5 Sediment SC-07
1.6 Water SCW-02
1.7 Sediment SC-08 Water SCW-03
1.8 Sediment SC-09 Water SCW-04
1.9 Sediment SC-10 Water SCW-05
1.10 Sediment SC-11 Water SCW-06
Stream 1 Sample Locations
Inset Map 'B'
Rock SJC 96-13
Site 3.1 Sediment SC-17 Water SCW-11
Site 3.2 Sediment SC-18 Moss mat SC-19 Water SCW-12
Stream 3
0 200 400
metres
B
Inset Map 'A'
Copper (ppm) NTS 93L RGS (n=849 sites)
60 - 1700
49 - 59
34 - 48
25 - 33
3 - 24
88 ppm
73 ppm
67 ppm
68 ppm
66 ppm
67 ppm
57 ppm
59/55 ppm
76 ppm Cu in till
Cobble SJC 96-32 87 ppm Cu (ICP)
54/53 ppm
48 ppm
53/48 ppm
47 ppm
61/58 ppm
Cobble SJC 96-09: 466 ppm Cu (ICP); 27 ppb Au, 13 ppm Sb (INA)
Copper in Stream Sediments: Granisle Area
32/31 ppm
35 ppm
Cobble SJC 96-13: 214 ppm Cu, 2.3 ppm Ag (ICP); 68 ppb Au, 8.6 ppm Sb (INA)

Figure 3. Granisle study area: a) detailed location map of follow-up site locations; b) stream sediment copper (AAS) results.

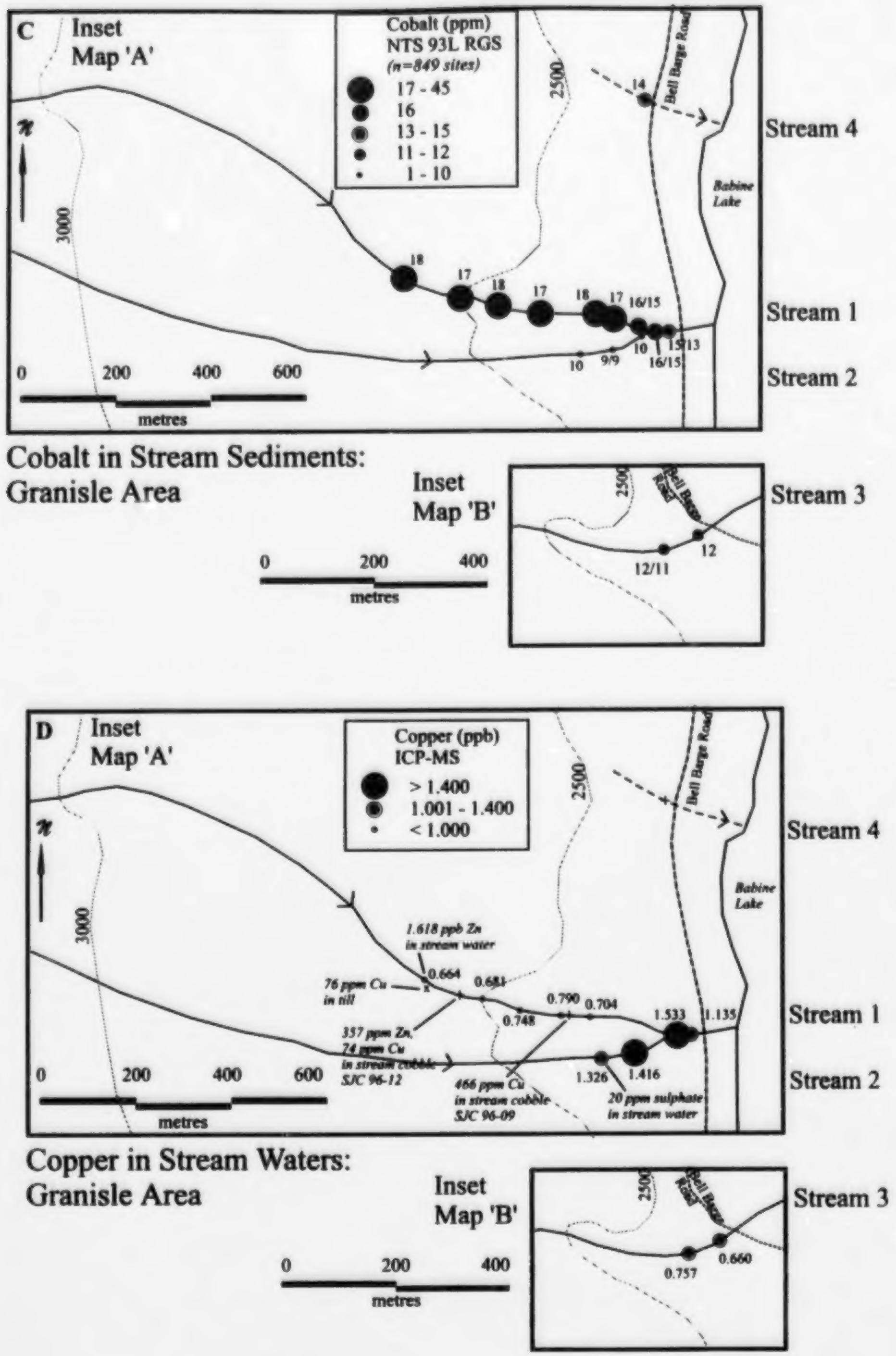
C
Inset Map 'A'
Cobalt (ppm) NTS 93L RGS (n=849 sites)
17 - 45
16
13 - 15
11 - 12
1 - 10
Stream 4
Bell Barge Road
Babine Lake
Stream 1
Stream 2
0 200 400 600 metres
Cobalt in Stream Sediments: Granisle Area
Inset Map 'B'
Stream 3
D
Inset Map 'A'
Copper (ppb) ICP-MS
> 1.400
1.001 - 1.400
< 1.000
1.618 ppb Zn in stream water
76 ppm Cu in till
357 ppm Zn, 74 ppm Cu in stream cobble SJC 96-12
466 ppm Cu in stream cobble SJC 96-09
20 ppm sulphate in stream water
Copper in Stream Waters: Granisle Area

Figure 3. Granisle study area: c) stream sediment cobalt (AAS) results; d) stream water copper (ICP-MS) results.

Several bedload rock samples returned elevated metal values. A small sub-angular boulder of chalcopyrite-pyrite-epidote-bearing fine-grained green volcanic rock (SJC 96-09) found in Stream 1 about 300 metres upstream of the Bell barge road returned elevated concentrations of 466 ppm copper, 27 ppb gold and 13 ppm antimony (Table 7). Copper concentrations of up to 87 ppm, and zinc concentrations up to 357 ppm, were returned by other bed load rock samples in this stream. In Stream 3, a light green pyritic volcanic cobble returned elevated concentrations of copper (214 ppm), zinc (166 ppm), silver (2.3 ppm), gold (68 ppb), arsenic (160 ppm) and antimony (8.6 ppm).

Copper values up to 1.533 ppb are present in Granisle-area stream waters. Counter to sediment copper results, relatively higher copper concentrations occur in Stream 2 waters (up to 1.416 ppb), and in the lower reach of Stream 1 below its confluence with Stream 2. In comparison, the median copper content of 176 Babine belt lake waters is 0.826 ppb (Cook *et al.*, 1999).

Relatively higher sulphate (14-20 ppm; 3-5 times that of upstream sites in Stream 1), calcium and TDS levels are also present in Stream 2 and in the lower reach of Stream 1. No multi-element water geochemical data was obtained from Stream 4. However, unfiltered water from this site does not have appreciably different fluoride, sulphate, TDS or conductivity levels from most other stream water sites in the area.

AREA 2: TAKLA LAKE (NTS 93N/4)

Location, Geology and Regional Geochemistry

The anomalous RGS site (93N04 831893) is located on an unnamed creek flowing into the north side of the Northwest Arm of Takla Lake. It is accessible by boat from Takla Narrows, 2-3 kilometres to the southeast (Figures 4a, b). The creek originates on the eastern slope of Mt. Blanchet, and occupies a narrow and deeply-incised drainage channel in the area between the main and Northwest arms of Takla Lake. Much of the valley is

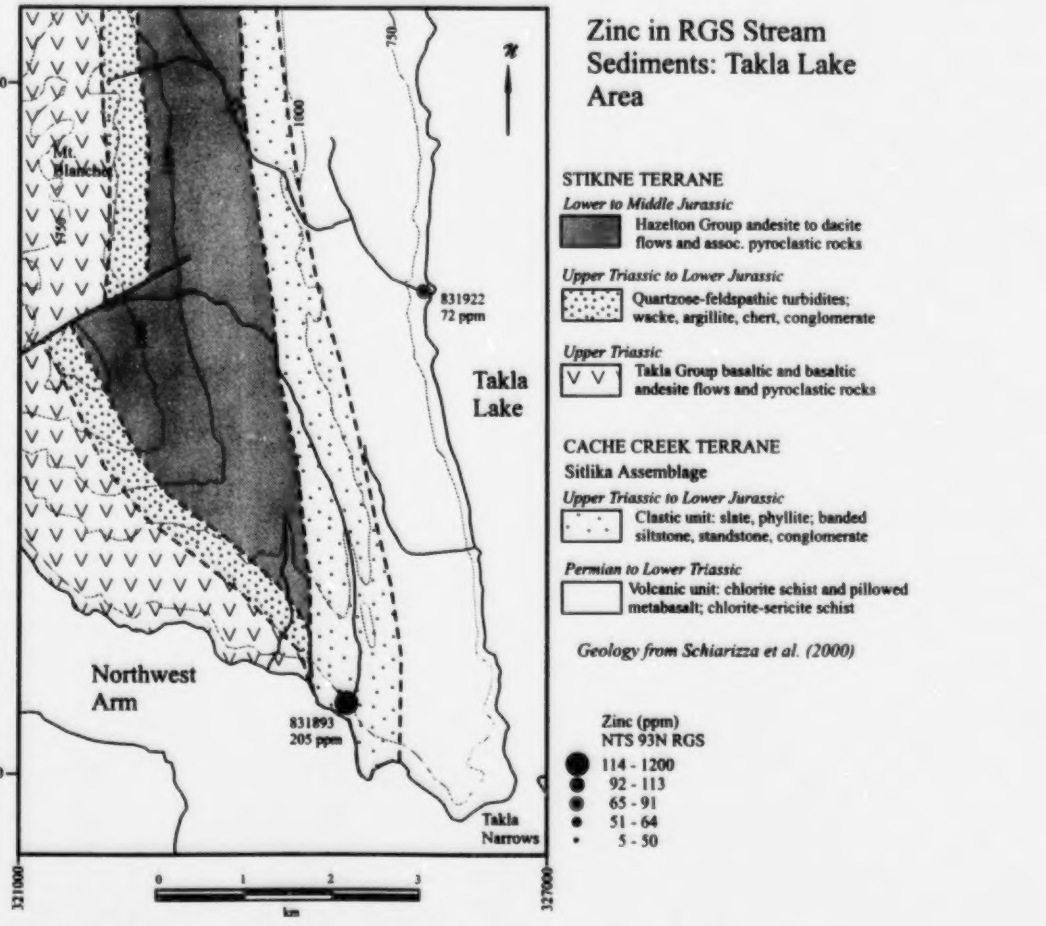
Zinc in RGS Stream Sediments: Takla Lake Area
6125000
6117000
321000
327000
Mt. Blanchet
831922 72 ppm
831893 205 ppm
Takla Lake
Northwest Arm
Takla Narrows
0 1 2 3 km
STIKINE TERRANE
Lower to Middle Jurassic
Hazelton Group andesite to dacite flows and assoc. pyroclastic rocks
Upper Triassic to Lower Jurassic
Quartzose-feldspathic turbidites; wacke, argillite, chert, conglomerate
Upper Triassic
Takla Group basaltic and basaltic andesite flows and pyroclastic rocks
CACHE CREEK TERRANE
Sitlika Assemblage
Upper Triassic to Lower Jurassic
Clastic unit: slate, phyllite; banded siltstone, standstone, conglomerate
Permian to Lower Triassic
Volcanic unit: chlorite schist and pillowed metabasalt; chlorite-sericite schist
Geology from Schiarizza et al. (2000)
Zinc (ppm) NTS 93N RGS
114 - 1200
92 - 113
65 - 91
51 - 64
5 - 50

Figure 4a. Takla Lake study area: geological setting and RGS stream sediment zinc results.

occupied by the Upper Triassic to Lower Jurassic clastic unit of the Sitlika Assemblage (Schiarizza and MacIntyre, 1999; Schiarizza et al., 1998, 2000). It comprises a narrow belt of slate and argillite with lesser sandstone, limestone and conglomerate and forms the western contact of the Sitlika Assemblage, in fault contact with Hazelton Group volcanic rocks of the Stikine Terrane to the west. The Sitlika volcanic unit is exposed to the east of the clastics, along the western side of Takla Lake in this area. Of probable Permian to Lower Triassic age, it comprises primarily chlorite schist, pillowed metabasalt and chlorite-sericite schist, and has been correlated with volcanic and plutonic rocks of the Kutcho Formation on the basis of lithological, geochemical and isotopic similarities (Schiarizza *et al.*, 1998; Childe and Schiarizza, 1997).

The anomalous RGS site (831893), referred to here as Stream 2 (Figure 4b), contains elevated sediment concentrations of zinc (205 ppm), antimony (2.2 ppm), cobalt (25 ppm) and nickel (213 ppm; Jackaman, 1998b). Moderately elevated concentrations of lead (7 ppm) and copper (53 ppm) were also present. As indicated in Manson River-area watershed geochemical maps of Jackaman (1998b), the wedge of land between the Northwest and main arms of Takla Lake is characterized

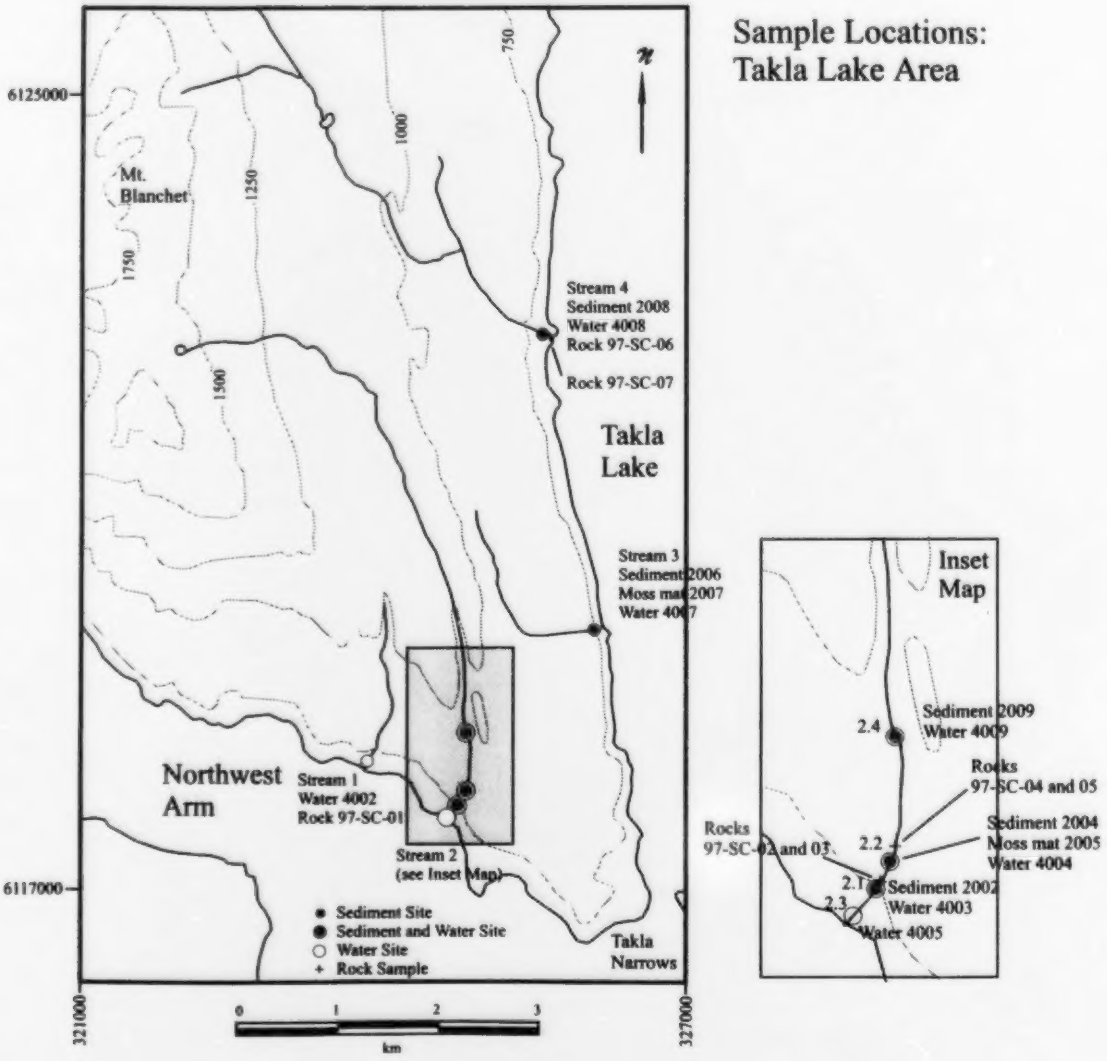
Sample Locations:
Takla Lake Area
6125000
6117000
321000
327000
750
1000
1250
1750
1500
Mt. Blanchet
Stream 4
Sediment 2008
Water 4008
Rock 97-SC-06
Rock 97-SC-07
Takla Lake
Stream 3
Sediment 2006
Moss mat 2007
Water 4007
Northwest Arm
Stream 1
Water 4002
Rock 97-SC-01
Stream 2
(see Inset Map)
Sediment Site
Sediment and Water Site
Water Site
Rock Sample
Takla Narrows
0
1
2
3
km
Inset Map
2.4
Sediment 2009
Water 4009
Rocks
97-SC-04 and 05
Rocks
97-SC-02 and 03
2.2
Sediment 2004
Moss mat 2005
Water 4004
2.1
Sediment 2002
Water 4003
2.3
Water 4005

Figure 4b. Takla Lake study area: follow-up sample site locations.

on a regional scale by elevated stream sediment lead concentrations (at least 7 ppm) and moderate Cu-Pb-Zn-Ag-Ba base metal anomaly ratings in several adjoining watersheds. This area corresponds closely to the distribution of Takla Group, Hazelton Group and Sitlika Assemblage rocks on the west side of Takla Lake. Three adjacent streams were also sampled as part of this case study: a small creek about 1 km to the northwest (Stream 1; water sample only), and two streams (3 and 4) on the west side of the main body of Takla Lake, to the north of Takla Narrows (Figure 4b). An RGS site (831922) at Stream 4 exhibits generally background-level metal values.

Results

Resampling of the original RGS site (831893) in Stream 2 confirmed the original RGS anomaly (205 ppm zinc, 2.2 ppm antimony), returning concentrations of 234 ppm zinc and 2.8 ppm antimony (Figures 5a and 5b). Similar zinc and antimony values, up to 252 ppm and 2.6 ppm, respectively, were obtained at two other sediment sites upstream. A moss mat sample (972005) from one such site contained 329 ppm zinc and 57 ppb gold, but no other elevated sediment gold results were obtained (Table 5). Sediments and moss mats from Streams 3 and 4 to the north contain lower zinc levels. However, Stream 4 follow-up zinc results (141 ppm) are greater than those obtained during the original RGS survey (72 ppm), and are within the top five percentiles of Manson River-area RGS zinc data. Copper concentrations are relatively high in Streams 3 and 4 (up to 67 ppm in sediments and 80 ppm in moss mats), compared to a maximum of only 50 ppm in Stream 2. It is notable that Stream 2, with the highest follow-up sediment zinc concentrations, largely drains the Sitlika clastic unit (Figures 4a, b; 5a). Stream 4, with the second-highest zinc concentration, also partly drains this unit. Conversely, the highest follow-up copper concentrations in sediments (Stream 3) and rock float (Stream 4) are in streams draining, in whole or in part, the Sitlika volcanic unit (Figure 5a). No sample reanalysis was conducted to confirm the single elevated gold in moss mat result (sample 972005).

Several rock samples collected as float from Stream 2, draining the Sitlika clastic unit, returned highly elevated lead results. In particular, two rock samples obtained from near sites 2.1 and 2.2 (Figure 5a) returned 748 ppm (97-SC-02) and 194 ppm lead (97-SC-04), respectively, and 1.1-1.4 ppm silver (Table 7). Two other samples from Streams 1 and 2 returned 68 ppm and 56 ppm lead, respectively. In addition, analysis of a schistose rock (97-SC-07) from near the mouth of Stream 4, where elevated copper (67 ppm) occurs in follow-up sediments, returned 516 ppm copper (Table 7). Re-analysis of this sample yielded similar results (591 ppm copper).

Zinc or antimony levels are not particularly high in Stream 2 waters, where elevated concentrations of these elements occur in sediments. However, relatively high concentrations of zinc (1.7 ppb), molybdenum (4.73 ppb) and selenium (3.5 ppb) are present in Stream 1 waters (974002), from which no sediment sample was obtained. Water geochemistry of this stream is markedly different from that of the others in the area. For example, elevated concentrations of 0.90 ppb uranium, 110 ppb fluoride and 44 ppm sulphate are present (Table 6). In the case of sulphate, this concentration falls within the top ten percentiles of B.C. RGS sulphate data (Figure 5c). In addition, magnesium (10,168 ppb) and potassium (721 ppb) concentrations are also relatively high, approximately 4 times that of the adjacent creeks.

An interesting result here are the high nickel levels present in follow-up stream sediments, waters and rock float of Stream 2, which primarily drains the Sitlika clastic unit. Sediment nickel concentrations are in the range 146-170 ppm (Figure 5d), considerably greater than the 22 ppm background level (RGS regional median; Jackaman, 1998b). A silicified float sample with pyrite stringers, obtained from the stream bed near the re-sampled RGS site on Stream 2 (97-SC-03; Table 7), returned 2291 ppm nickel and elevated levels of lead (56 ppm), cobalt (107 ppm) and chromium (752 ppm ICP; 2600 ppm INAA). Waters collected at all four sites on this creek also have relatively high dissolved nickel levels (1.40-1.97 ppb).

AREA 3: BIVOUAC CREEK (NTS 93N/4)

Location, Geology and Regional Geochemistry

Four RGS sites (93N04 831900, 1902, 1904 and 1906) are located in the western headwaters of Bivouac Creek, which flows into the southern end of Takla Lake (Figure 6) about 14 kilometres south of Takla Narrows. There is no road or boat access. Interpretation of geochemical results here has been aided by recent detailed geological mapping conducted under the Nechako NATMAP project. The regional geological compilation of the area (Bellefontaine *et al.*, 1995) shows it to be underlain by Cache Creek Group sedimentary rocks, but recent bedrock mapping by Schiarizza *et al.* (1998, 2000) and Schiarizza and MacIntyre (1999) indicates the anomalous western part of Bivouac Creek to be instead underlain by the clastic unit of the Sitlika Assemblage. This is the same mapped belt of Sitlika clastics which floors streams with anomalous sediment zinc levels at Takla Narrows to the north (Figure 4).

Three of the four RGS sites are characterized by elevated sediment zinc concentrations of at least 113 ppm (Table 4), with two of these (831902, 831904) having

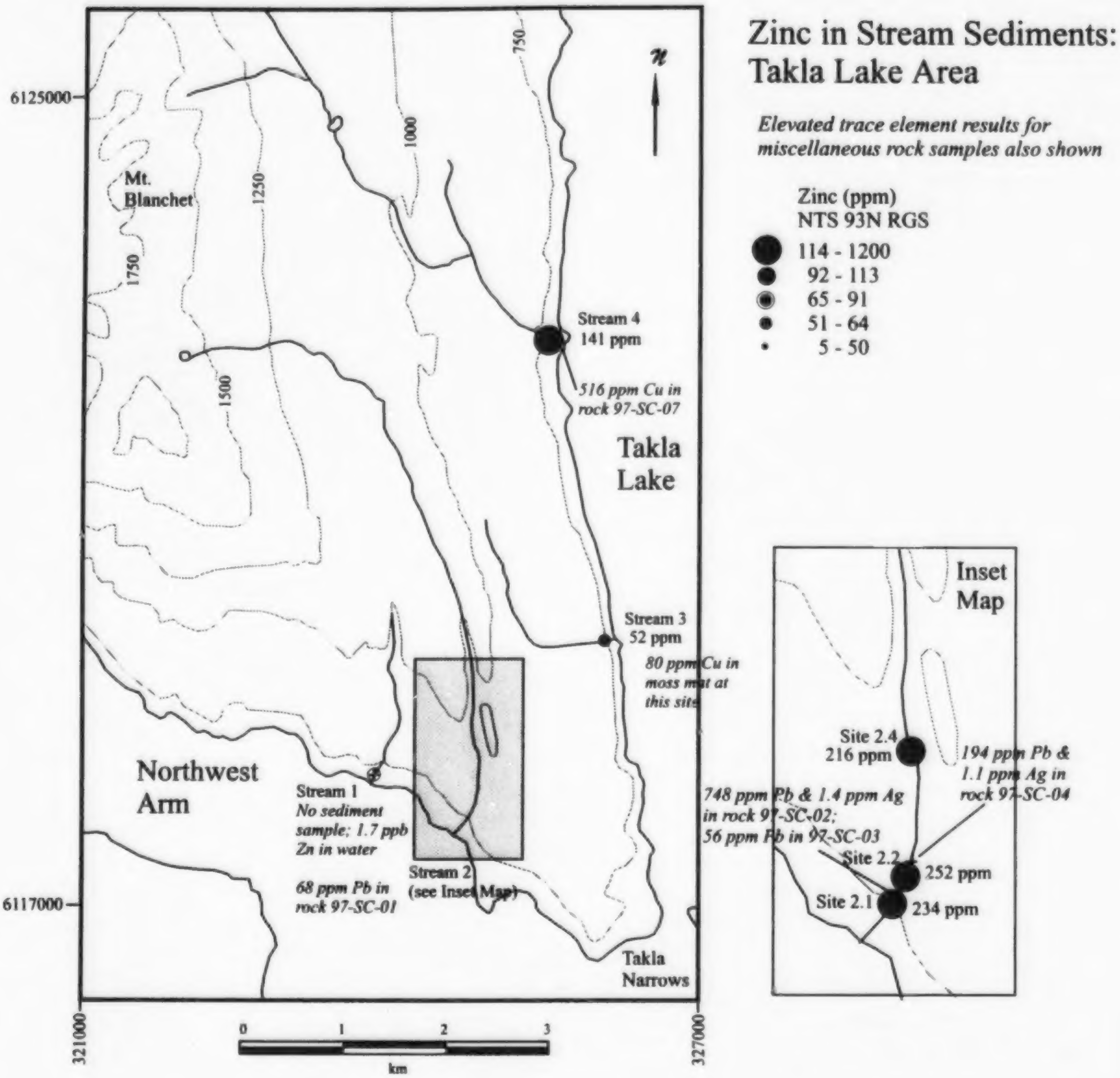
Zinc in Stream Sediments: Takla Lake Area
Elevated trace element results for miscellaneous rock samples also shown
Zinc (ppm)
NTS 93N RGS
● 114 - 1200
● 92 - 113
◉ 65 - 91
● 51 - 64
• 5 - 50
N
6125000
6117000
321000
327000
0
1
2
3
km
Mt. Blanchet
1750
1500
1250
1000
750
Stream 4
141 ppm
516 ppm Cu in rock 97-SC-07
Takla Lake
Stream 3
52 ppm
80 ppm Cu in moss mat at this site
Northwest Arm
Stream 1
No sediment sample; 1.7 ppb Zn in water
68 ppm Pb in rock 97-SC-01
Stream 2
(see Inset Map)
Takla Narrows
Inset Map
Site 2.4
216 ppm
194 ppm Pb & 1.1 ppm Ag in rock 97-SC-04
748 ppm Pb & 1.4 ppm Ag in rock 97-SC-02;
56 ppm Pb in 97-SC-03
Site 2.2
252 ppm
Site 2.1
234 ppm

Figure 5a. Takla Lake study area results: zinc (AAS) in stream sediments. Class intervals represent percentile ranges (Table 4) for 1029 RGS zinc concentrations in the Manson River (NTS 93N) map area.

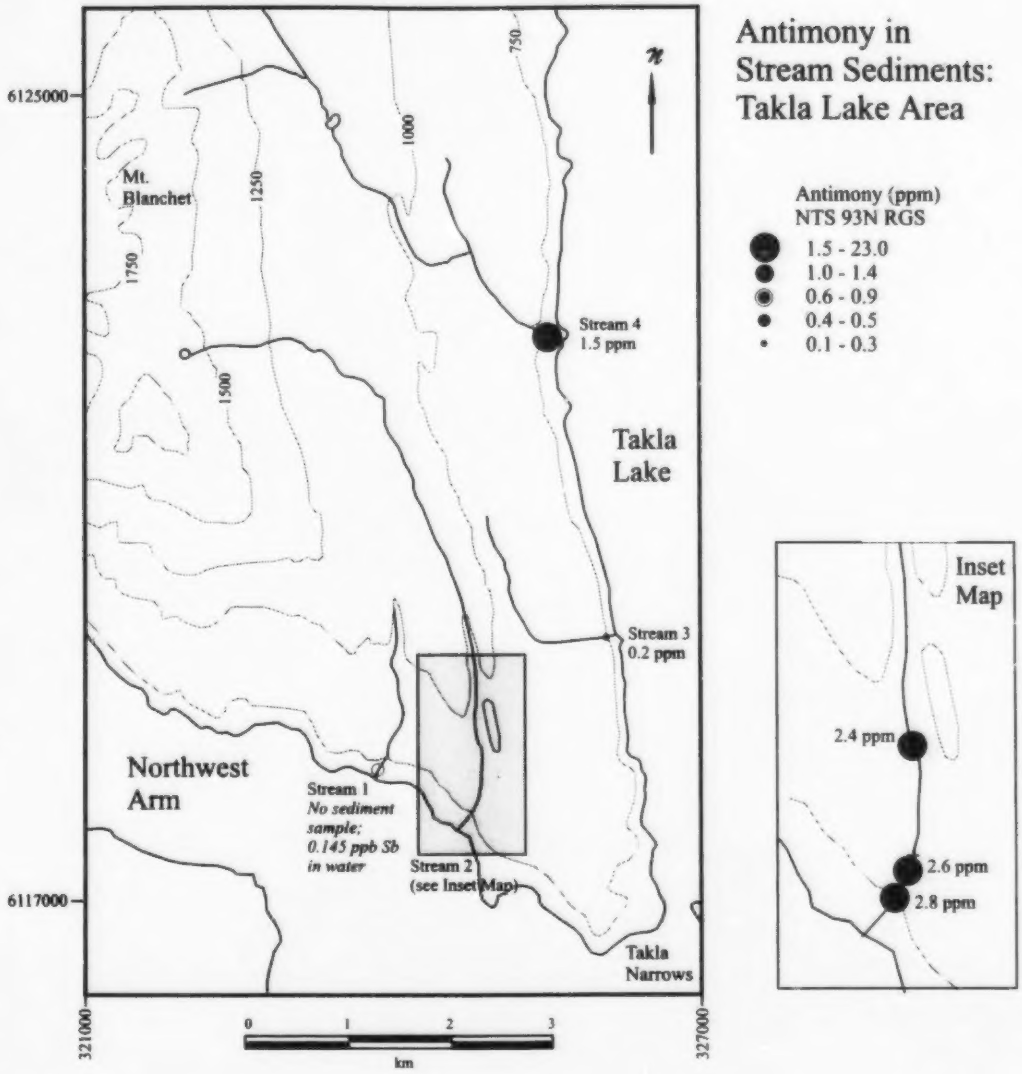
Antimony in Stream Sediments: Takla Lake Area
Antimony (ppm) NTS 93N RGS
● 1.5 - 23.0
● 1.0 - 1.4
● 0.6 - 0.9
● 0.4 - 0.5
• 0.1 - 0.3
N
6125000
6117000
321000
327000
0 1 2 3
km
750
1000
1250
1500
1750
Mt. Blanchet
Stream 4 1.5 ppm
Takla Lake
Stream 3 0.2 ppm
Northwest Arm
Stream 1 No sediment sample; 0.145 ppb Sb in water
Stream 2 (see Inset Map)
Takla Narrows
Inset Map
2.4 ppm
2.6 ppm
2.8 ppm

Figure 5b. Takla Lake study area results: antimony (AAS) in stream sediments. Class intervals represent percentile ranges (Table 4) for 1029 RGS antimony concentrations in the Manson River map area.

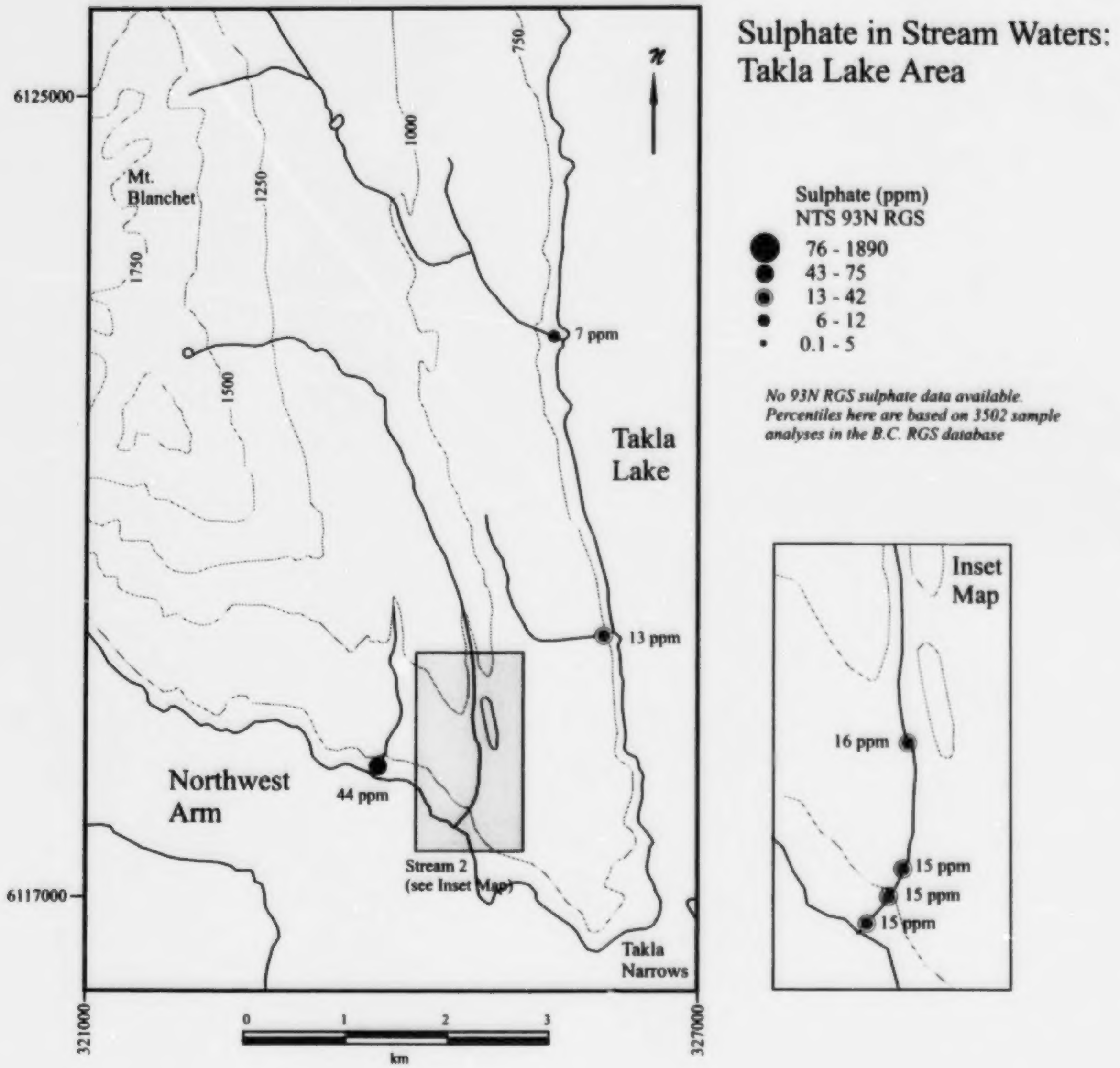
Sulphate in Stream Waters: Takla Lake Area
Sulphate (ppm)
NTS 93N RGS
● 76 - 1890
● 43 - 75
● 13 - 42
● 6 - 12
• 0.1 - 5
No 93N RGS sulphate data available. Percentiles here are based on 3502 sample analyses in the B.C. RGS database
6125000
6117000
321000
327000
Mt. Blanchet
1750
1500
1250
1000
750
7 ppm
13 ppm
44 ppm
Takla Lake
Northwest Arm
Stream 2 (see Inset Map)
Takla Narrows
N
0
1
2
3
km
Inset Map
16 ppm
15 ppm
15 ppm
15 ppm

Figure 5c. Takla Lake study area results: sulphate in unfiltered stream waters.

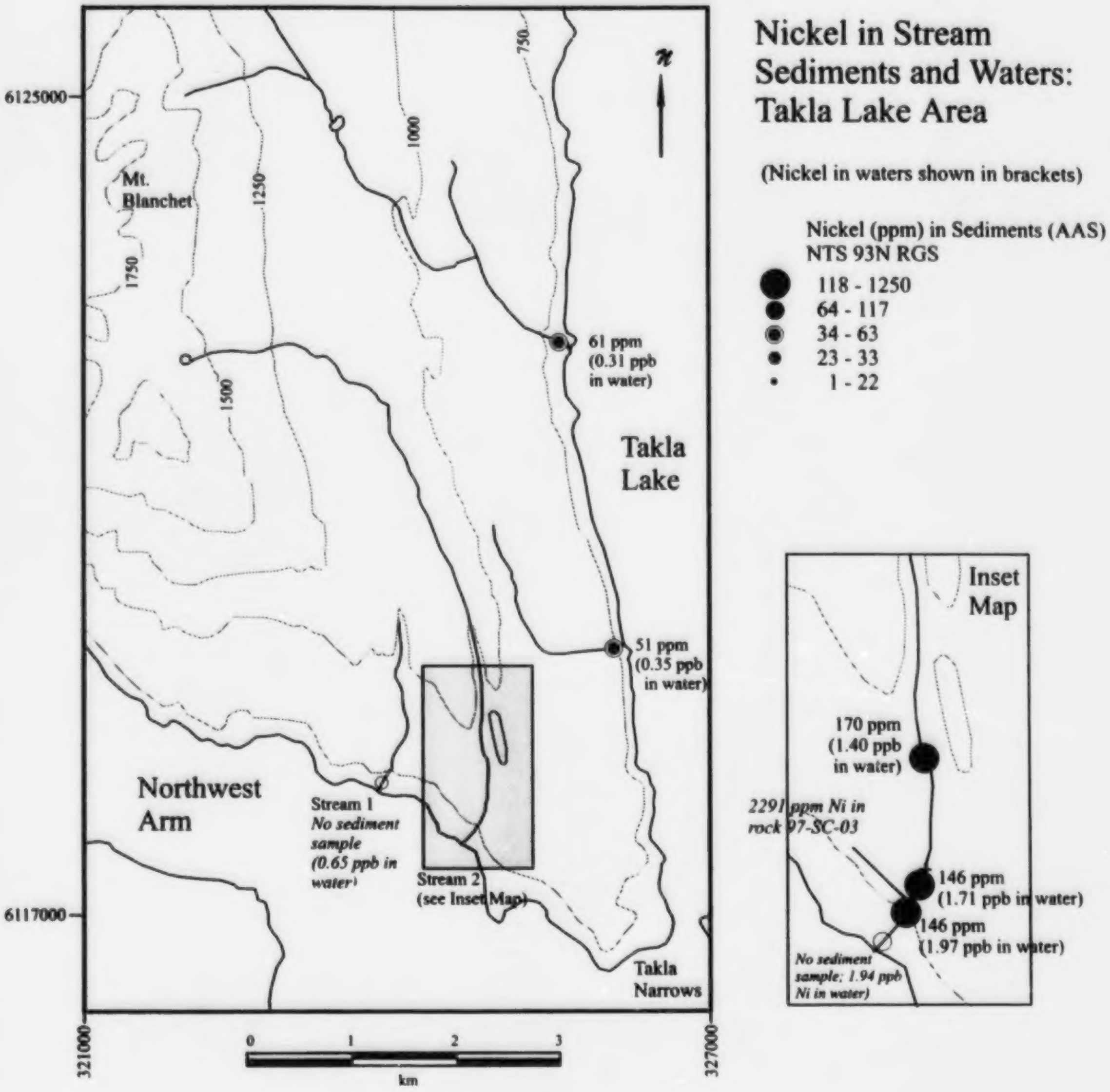
Nickel in Stream Sediments and Waters: Takla Lake Area
(Nickel in waters shown in brackets)
Nickel (ppm) in Sediments (AAS)
NTS 93N RGS
● 118 - 1250
● 64 - 117
◉ 34 - 63
● 23 - 33
• 1 - 22
N
6125000
6117000
321000
327000
0
1
2
3
km
Mt. Blanchet
1750
1250
1500
1000
750
61 ppm
(0.31 ppb
in water)
Takla
Lake
51 ppm
(0.35 ppb
in water)
Northwest
Arm
Stream 1
No sediment
sample
(0.65 ppb in
water)
Stream 2
(see Inset Map)
Takla
Narrows
Inset
Map
170 ppm
(1.40 ppb
in water)
2291 ppm Ni in
rock 97-SC-03
146 ppm
(1.71 ppb in water)
146 ppm
(1.97 ppb in water)
No sediment
sample; 1.94 ppb
Ni in water)

Figure 5d. Takla Lake study area results: nickel in stream sediments (AAS) and filtered stream waters (ICP-MS). Class intervals for sediments represent percentile ranges for 1029 RGS nickel concentrations in the Manson River map area.

zinc concentrations in the range 153-235 ppm (Figure 6), within the top five percentiles of data for the Manson River map area. One site (831904) also contains elevated concentrations of antimony (2.2 ppm), silver (1.1 ppm) and bromine (71.7 ppm), in addition to 153 ppm zinc. Moderately-elevated concentrations of copper (100 ppm), lead (7 ppm) and mercury (220 ppb) are also present here, along with upper five-percentile base metal and precious metal anomaly rankings of 9 and 11, respectively (Jackaman, 1998b).

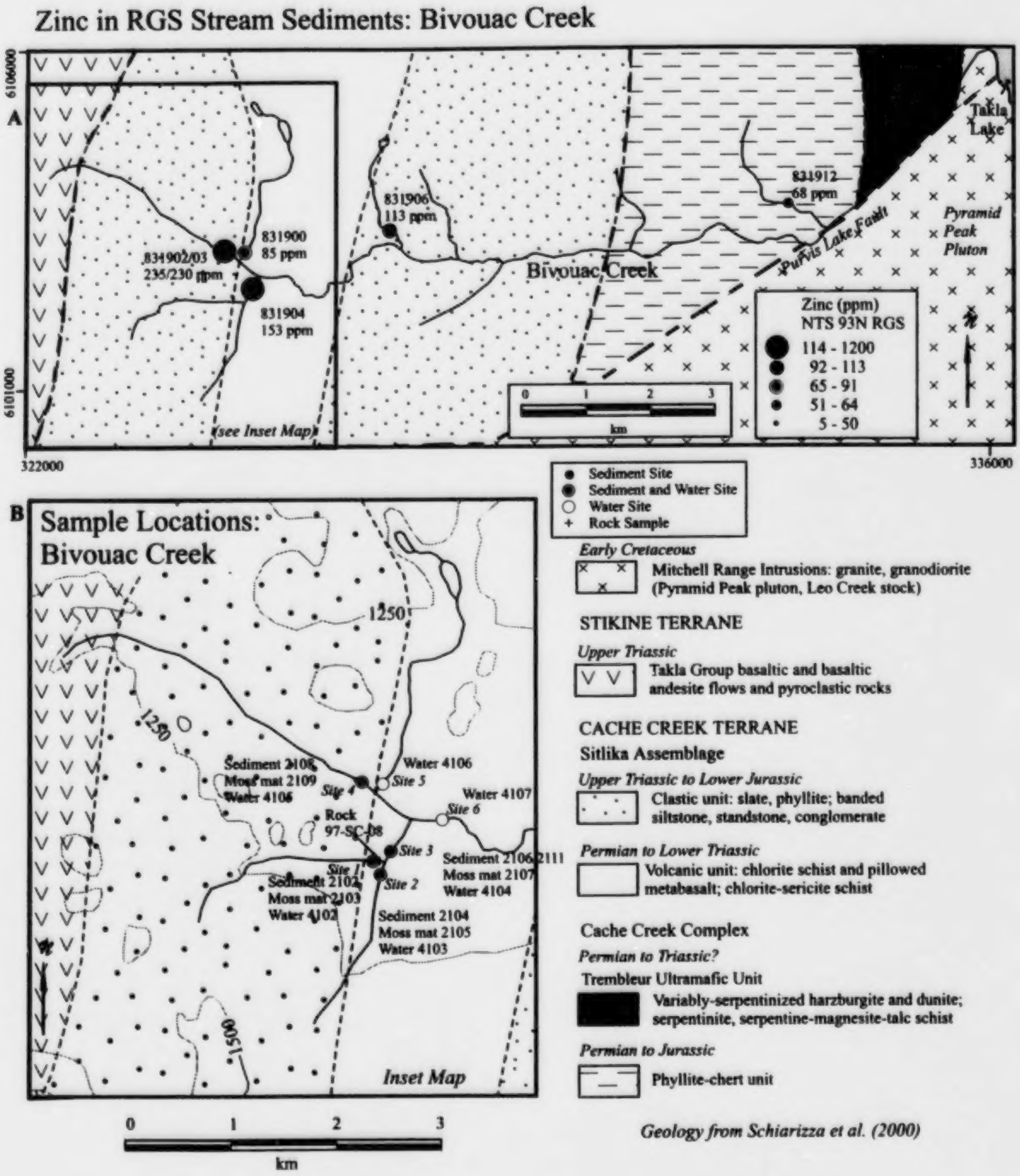
Zinc in RGS Stream Sediments: Bivouac Creek
A
6106000
6101000
322000
336000
831902/03
235/230 ppm
831900
85 ppm
831904
153 ppm
831906
113 ppm
831912
68 ppm
Bivouac Creek
Purvis Lake Fault
Takla Lake
Pyramid Peak Pluton
(see Inset Map)
0 1 2 3
km
Zinc (ppm)
NTS 93N RGS
114 - 1200
92 - 113
65 - 91
51 - 64
5 - 50
B
Sample Locations:
Bivouac Creek
1250
1250
1500
Sediment 2108
Moss mat 2109
Water 4105
Site 4
Water 4106
Site 5
Water 4107
Site 6
Rock
97-SC-08
Site 3
Site 1
Site 2
Sediment 2102
Moss mat 2103
Water 4102
Sediment 2106/2111
Moss mat 2107
Water 4104
Sediment 2104
Moss mat 2105
Water 4103
Inset Map
0 1 2 3
km
● Sediment Site
● Sediment and Water Site
○ Water Site
+ Rock Sample
Early Cretaceous
Mitchell Range Intrusions: granite, granodiorite (Pyramid Peak pluton, Leo Creek stock)
STIKINE TERRANE
Upper Triassic
Takla Group basaltic and basaltic andesite flows and pyroclastic rocks
CACHE CREEK TERRANE
Sitlika Assemblage
Upper Triassic to Lower Jurassic
Clastic unit: slate, phyllite; banded siltstone, standstone, conglomerate
Permian to Lower Triassic
Volcanic unit: chlorite schist and pillowed metabasalt; chlorite-sericite schist
Cache Creek Complex
Permian to Triassic?
Trembleur Ultramafic Unit
Variably-serpentinized harzburgite and dunite; serpentinite, serpentine-magnesite-talc schist
Permian to Jurassic
Phyllite-chert unit
Geology from Schiarizza et al. (2000)

Figure 6. Bivouac Creek study area: a) geological setting and RGS stream sediment zinc results, and b) follow-up sample site locations.

Results

Resampling of two of the four RGS sites here (831902 and 1904) confirmed the original RGS zinc anomalies (153-235 ppm), returning concentrations of 242-263 ppm zinc (Figure 7a). These are within the upper five percentiles of stream sediment zinc data for the Manson River (NTS 93N) map area. As a group, elevated sediment zinc concentrations at the four sample sites here are remarkably homogenous, and all at least partly drain the Sitlika clastic unit newly defined in the area. Corresponding moss mat samples here have only slightly lower zinc values, in the range 199-246 ppm. Furthermore, elevated cadmium concentrations up to 3.4 ppm (Figure 7b), antimony up to 1.9 ppm, and moderately elevated lead up to 10 ppm are also present in sediment and moss mat samples at all four sites. However, RGS copper and silver anomalies at original site 831904 were not repeated in this study, which returned only background levels of the two metals. A single float sample of pyritic silicified felsic volcanic (97-SC-08) from the stream bed at site 1 returned 39 ppm lead (Table 7).

Stream waters were obtained at six sites, four with accompanying sediment samples and two without (Figure 6). Water geochemical results are inconclusive. None contain appreciable concentrations of zinc, cadmium or antimony (Table 6), although a downstream sample (974107) at site 6 on Bivouac Creek returned 2.0 ppb copper and 0.7 ppb lead. Sulphate concentrations (Figure 7c) are marginally greater in three waters draining the southern part of the area (10-11 ppm), compared to two waters draining the north and west (6 ppm). There are no RGS sulphate data for the Manson River (NTS 93N) map area with which to directly compare these results. However, Bivouac Creek sulphate results are not particularly high, near the 70* percentile (12 ppm), relative to available British Columbia RGS stream water sulphate results (3502 sites; W. Jackaman, personal communication, 1998).

SUMMARY

Follow-up sampling at three anomalous RGS sites (Granisle, Takla Lake and Bivouac Creek areas) in central British Columbia confirmed, in most cases, the presence of elevated base metal concentrations in stream sediments. In the Granisle area, resampling of the lower reaches of four streams draining Takla Group rocks did not confirm original highly-elevated RGS copper and gold concentrations. Nevertheless, a small chalcopyrite-bearing boulder was encountered in Stream 1, and sediment sites on Stream 1 and Stream 4 have elevated copper concentrations of up to 73 ppm and of 88 ppm, respectively. In the case of Stream 4, this value is within the upper two percentiles of RGS copper data (>80 ppm) for the entire Smithers (NTS 93L) map area.

In both the Takla Lake and Bivouac Creek areas, high zinc concentrations in stream sediments drain a north-south trending clastic unit of the Sitlika assemblage recently mapped by Schiarizza *et al.* (2000). At Takla Lake, elevated sediment concentrations of zinc and antimony in Stream 2 draining the Sitlika clastic unit confirm the original RGS anomaly at this site. Elevated lead concentrations were also found in several alluvial stream bed cobbles here, and elevated nickel levels are present in sediments, waters and rocks. Conversely, moderately elevated copper concentrations are present in sediments of Streams 3 and 4 which drain, in whole or in part, the volcanic unit of the Sitlika assemblage. At Bivouac Creek, elevated concentrations of zinc and cadmium, with moderately elevated antimony and lead, are present at four sediment sites draining the Sitlika assemblage clastic unit. Only background levels of copper are present. In comparison to other areas, elevated zinc concentrations in surficial materials are also present above similar clastic sedimentary rocks at the Bornite property (MINFILE 93K 067) to the southeast, west of Mt. Sidney Williams, where Mowatt (1996) reported the presence of elevated zinc in soils above sulphide-bearing argillite.

These case study results underline the importance of relating regional geochemical results to geological mapping in the search for new mineral deposits. Continuing bedrock geological mapping programs throughout British Columbia will undoubtedly lead to the improved geological framework necessary to better interpret the extensive RGS stream sediment geochemical database.

ACKNOWLEDGMENTS

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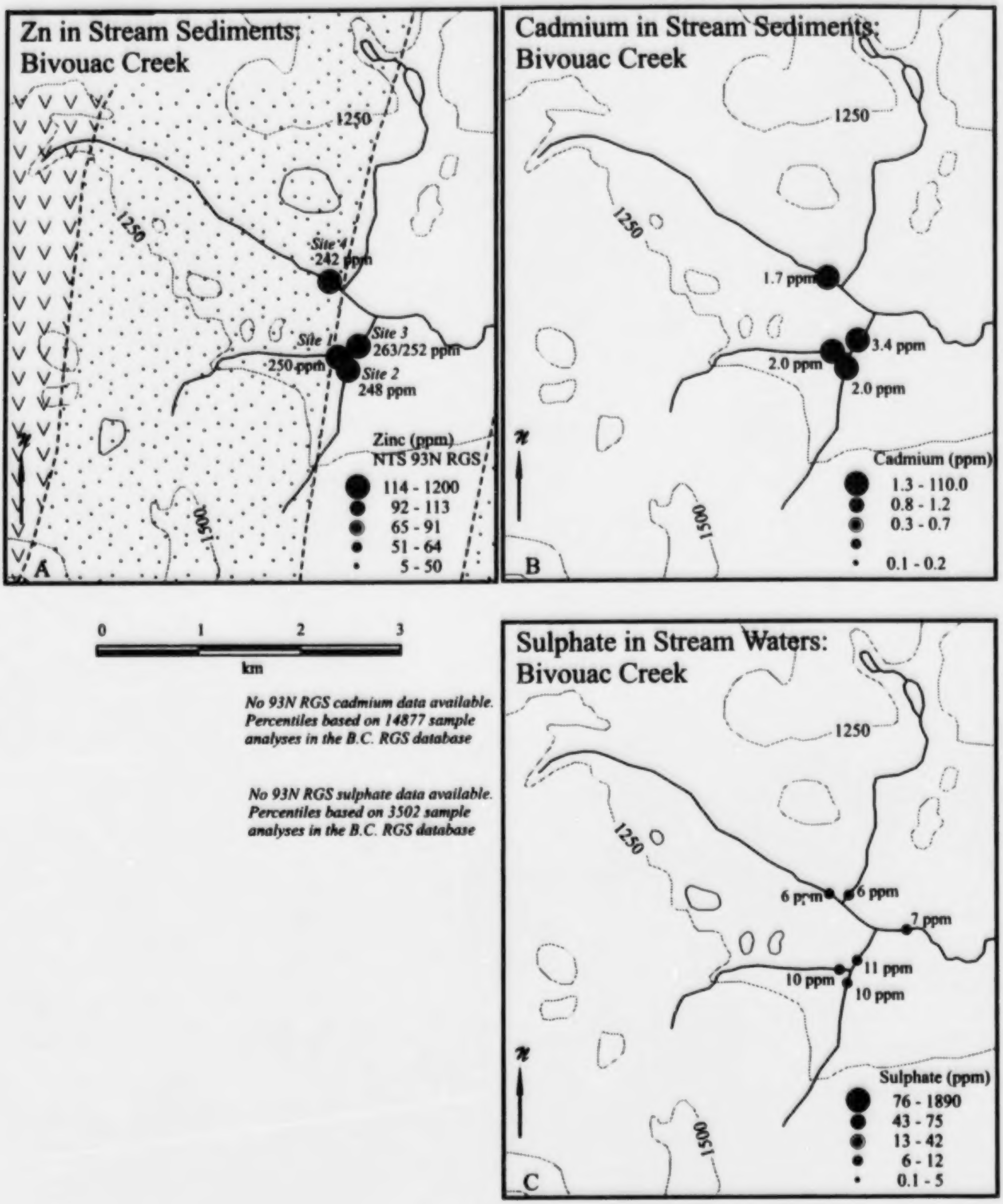
Zn in Stream Sediments: Bivouac Creek
1250
Site 4
242 ppm
Site 1
250 ppm
Site 3
263/252 ppm
Site 2
248 ppm
1500
Zinc (ppm)
NTS 93N RGS
114 - 1200
92 - 113
65 - 91
51 - 64
5 - 50
A
Cadmium in Stream Sediments: Bivouac Creek
1250
1.7 ppm
3.4 ppm
2.0 ppm
2.0 ppm
1500
Cadmium (ppm)
1.3 - 110.0
0.8 - 1.2
0.3 - 0.7
0.1 - 0.2
B
0
1
2
3
km
Sulphate in Stream Waters: Bivouac Creek
1250
6 ppm
6 ppm
7 ppm
11 ppm
10 ppm
10 ppm
1500
Sulphate (ppm)
76 - 1890
43 - 75
13 - 42
6 - 12
0.1 - 5
C

No 93N RGS cadmium data available. Percentiles based on 14877 sample analyses in the B.C. RGS database

No 93N RGS sulphate data available. Percentiles based on 3502 sample analyses in the B.C. RGS database

Figure 7. Bivouac Creek study area results: a) zinc (AAS) in stream sediments, b) cadmium (AAS) in stream sediments, and c) sulphate in unfiltered stream waters. Class intervals for zinc represent percentile ranges (Table 4) for 1029 RGS element concentrations in the Manson River (NTS 93N) map area.

TABLE 5. STREAM SEDIMENT GEOCHEMISTRY RESULTS

AAS Results: Stream Sediments

Study Area		Map	ID	Rep	Sample Type		Ag ppm	As ppm	Bi ppm	Cd ppm	Co ppm	Cu ppm	Fe %	F ppm	Hg ppb	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Sb ppm	V ppm	Zn ppm	Se ppm	Te ppm	LOI %
Granisle	1	93L/16	96-SC- 01		sediment		0.2	6.0	0.1	0.2	15	54	3.0	410	50	760	<2	21	5	0.7	82	76	-	-	9.1
		93L/16	96-SC- 02		*moss mat*		<0.2	5.8	0.1	0.2	13	53	3.2	430	60	648	<2	20	6	0.8	72	81	-	-	11.5
		93L/16	96-SC- 03	10	sediment		<0.2	6.4	0.1	0.2	16	61	3.4	420	60	860	2	21	6	0.7	85	85	-	-	10.4
		93L/16	96-SC- 04	20	sediment	*f. dup. of 96-SC-03*	<0.2	6.2	0.1	<0.2	15	58	3.2	430	60	810	2	21	5	0.7	82	80	-	-	9.4
		93L/16	96-SC- 05	10	sediment		0.2	6.0	0.1	0.2	16	59	3.1	420	50	890	2	21	5	0.8	84	80	-	-	9.2
		93L/16	96-SC- 06	20	sediment	*f. dup. of 96-SC-05*	<0.2	5.9	0.1	<0.2	15	55	2.9	440	50	830	2	21	5	0.8	79	77	-	-	10.4
		93L/16	96-SC- 07		sediment		0.2	6.0	0.1	0.3	18	67	3.6	430	60	920	<2	23	6	0.8	94	82	-	-	11.9
		93L/16	96-SC- 08		sediment		<0.2	6.1	0.1	0.2	17	66	3.3	360	50	900	2	22	5	0.8	97	84	-	-	9.9
		93L/16	96-SC- 09		sediment		<0.2	6.6	0.1	0.2	18	68	3.6	430	50	930	2	22	6	0.8	96	83	-	-	10.1
		93L/16	96-SC- 10		sediment		0.2	6.9	0.1	0.2	17	67	3.2	420	60	860	<2	22	6	0.9	83	78	-	-	8.6
		93L/16	96-SC- 11		sediment		0.2	6.1	0.1	0.2	18	73	3.5	420	50	1120	2	23	6	0.8	90	97	-	-	10.8
		93L/16	96-SC- 12		sediment		0.2	6.1	0.1	0.2	17	57	3.0	390	30	840	2	21	4	0.8	88	81	-	-	8.6
	2	93L/16	96-SC- 13		sediment		0.2	5.2	0.1	0.2	10	47	3.0	420	50	506	<2	18	5	0.6	68	72	-	-	10.5
		93L/16	96-SC- 14	10	sediment		<0.2	5.1	0.1	0.2	9	53	3.1	420	100	533	<2	18	4	0.6	61	73	-	-	14.8
		93L/16	96-SC- 15	20	sediment	*f. dup. of 96-SC-14*	0.2	5.0	0.1	<0.2	9	48	2.8	410	70	495	2	17	4	0.6	63	69	-	-	13.2
		93L/16	96-SC- 16		sediment		0.2	5.2	0.1	0.2	10	48	3.0	400	70	829	<2	17	5	0.6	61	74	-	-	12.7
	3	93L/16	96-SC- 17		sediment		<0.2	6.4	0.1	<0.2	12	35	2.3	410	50	590	2	20	5	0.7	62	79	-	-	7.8
		93L/16	96-SC- 18		sediment		0.2	6.1	0.1	0.3	12	32	2.3	430	50	504	<2	20	6	0.7	62	72	-	-	7.0
		93L/16	96-SC- 19		*moss mat*		0.2	5.5	0.1	0.2	11	31	2.4	410	50	490	2	19	5	0.8	62	71	-	-	6.5
	4	93L/16	997037		sediment		0.2	7.1	<0.2	0.4	14	88	3.7	150	60	1070	1	21	9	0.5	87	77			16.5
Takla		93N/4	972001		sediment	*a. dup. of 972002*	0.2	8.2	0.5	1.5	20	50	2.8	180	40	485	7	148	7	2.1	51	237	1.8	0.1	6.1
		93N/4	972002		sediment		<0.2	9.3	0.3	1.6	19	49	2.9	180	40	502	5	146	6	2.8	52	234	1.7	0.1	7.3
		93N/4	972004		sediment		<0.2	8.1	0.3	1.7	18	50	2.8	310	50	563	6	146	6	2.6	53	252	2.0	0.1	10.7
		93N/4	972005		*moss mat*		<0.2	7.2	0.3	1.2	16	45	2.7	190	40	442	4	116	8	2.1	54	329	0.6	0.1	7.7
		93N/4	972006		sediment		<0.2	2.0	0.1	0.2	15	66	2	170	20	350	<2	51	3	0.2	55	52	0.5	0.1	7.9
		93N/4	972007		*moss mat*		<0.2	2.1	0.2	0.4	12	80	2.2	150	60	526	3	37	2	0.3	43	45	2.9	0.2	23.9
		93N/4	972008		sediment		<0.2	6.2	0.3	1.0	23	67	2.9	210	40	518	2	61	4	1.5	64	141	2.4	0.1	7.5
		93N/4	972009		sediment		<0.2	8.0	0.2	1.5	21	50	2.9	230	50	630	6	170	8	2.4	52	216	1.9	0.1	11.6
Bivouac Ck.		93N/4	972101		*moss mat*	*a. dup. of 972103*	<0.2	4.0	0.1	2.0	10	32	2.4	140	70	447	3	33	7	1.0	45	232	0.9	0.1	11.5
		93N/4	972102		sediment		0.2	5.2	0.2	2.0	11	36	2.7	180	80	580	3	37	8	1.3	50	250	1.0	0.2	12.8
		93N/4	972103		*moss mat*		0.2	4.2	0.1	2.2	9	33	2.5	260	70	456	5	33	9	1.0	47	235	0.9	0.1	12.7
		93N/4	972104		sediment		<0.2	6.0	0.2	2.0	12	36	2.7	280	80	560	3	32	8	1.4	49	248	0.8	0.1	12.4
		93N/4	972105		*moss mat*		<0.2	4.2	0.1	1.8	10	29	2.4	260	80	405	4	26	10	1.0	48	199	0.7	0.1	8.4
		93N/4	972106	10	sediment		<0.2	7.3	0.2	3.4	15	35	3.1	240	60	1220	4	41	9	1.9	53	263	0.9	0.1	9.4
		93N/4	972107		*moss mat*		<0.2	4.6	0.1	2.4	10	32	2.5	230	90	460	4	34	7	1.0	49	246	0.9	0.1	11.7
		93N/4	972108		sediment		<0.2	5.0	0.1	1.7	12	36	2.6	200	100	685	2	29	8	1.0	51	242	1.3	0.1	10.2
		93N/4	972109		*moss mat*		0.2	4.3	0.1	2.2	12	40	2.7	240	100	1170	3	30	6	0.9	47	237	1.8	0.1	14.3
		93N/4	972111	20	sediment	*f. dup. of 972106*	<0.2	16.0	0.2	1.2	16	40	3.2	540	60	980	12	40	8	2.0	64	252	0.7	0.1	9.6

TABLE 5. STREAM SEDIMENT GEOCHEMISTRY RESULTS

INAA Results: Stream Sediments

Study Area		Map	ID	Rep	Sample Type	Au ppb	As ppm	Ba ppm	Br ppm	Ca %	Co ppm	Cr ppm	Cs ppm	Fe %	Hf ppm	Na %	Rb ppm	Sb ppm	Sc ppm	Th ppm	U ppm	W ppm	Zn ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Yb ppm	Lu ppm	Mass g
Granisle	1	93L/16	96-SC- 01		sediment	7	7.8	520	4.0	2	16	100	2	4.3	4	1.9	41	1.1	20	3.2	2.0	<1	125	15	28	13	3.3	1.1	2.2	0.35	30.37
		93L/16	96-SC- 02		*moss mat*	8	7.9	410	<0.5	2	15	160	2	4.7	6	1.9	25	1.2	19	3.4	1.6	<1	115	17	32	13	3.5	1.2	2.4	0.37	27.08
		93L/16	96-SC- 03	10	sediment	4	9.7	610	5.1	2	17	94	2	4.5	4	2.0	26	1.1	20	3.1	<0.5	<1	139	16	30	15	3.6	1.2	2.3	0.37	25.85
		93L/16	96-SC- 04	20	sediment	<2	9.1	610	4.4	3	17	99	2	4.4	4	2.0	20	1.2	20	3.5	1.3	<1	135	16	31	14	3.4	1.2	2.5	0.39	25.48
		93L/16	96-SC- 05	10	sediment	6	10.0	570	4.9	2	19	93	2	4.7	4	2.0	38	1.2	21	3.2	2.2	<1	109	16	29	20	3.5	1.2	2.3	0.36	23.08
		93L/16	96-SC- 06	20	sediment	4	10.0	620	4.5	3	18	100	2	4.6	4	2.0	36	1.2	20	3.5	1.9	<1	135	16	29	16	3.4	1.1	2.2	0.36	27.21
		93L/16	96-SC- 07		sediment	<2	8.3	550	5.1	2	18	95	2	4.4	3	1.8	33	1.1	21	2.9	<0.5	<1	142	14	28	13	3.4	1.2	2.3	0.35	25.87
		93L/16	96-SC- 08		sediment	<2	8.0	570	3.5	2	17	84	2	4.2	3	1.8	40	1.1	19	2.8	1.7	<1	118	14	27	15	3.1	1.0	2.3	0.35	28.48
		93L/16	96-SC- 09		sediment	8	9.4	690	4.2	3	19	100	2	4.7	4	1.9	40	1.3	21	3.0	2.2	<1	144	15	28	12	3.4	1.1	2.3	0.36	25.69
		93L/16	96-SC- 10		sediment	<2	11.0	640	2.3	2	20	98	2	4.5	4	2.0	22	1.2	20	3.0	1.8	<1	129	15	32	17	3.4	1.2	2.4	0.39	27.54
		93L/16	96-SC- 11		sediment	11	9.4	600	<0.5	3	25	120	4	5.9	4	2.1	42	1.4	27	3.5	<0.5	<1	205	18	33	18	4.1	1.4	2.7	0.42	13.40
		93L/16	96-SC- 12		sediment	<3	10.0	690	3.9	3	23	120	2	5.5	4	2.4	20	1.5	25	3.6	3.3	<1	142	18	36	21	3.8	1.3	2.5	0.46	15.95
	2	93L/16	96-SC- 13		sediment	4	8.9	630	3.9	2	13	130	2	4.2	5	2.1	25	1.3	18	3.7	3.0	<1	111	17	30	16	3.5	1.2	2.3	0.36	28.00
		93L/16	96-SC- 14	10	sediment	9	7.9	590	6.0	2	13	120	2	4.3	5	2.0	25	1.4	18	3.6	2.8	<1	146	17	30	13	3.9	1.4	2.5	0.38	22.83
		93L/16	96-SC- 15	20	sediment	6	7.3	530	5.1	2	12	110	1	4.0	4	1.9	31	1.3	16	3.3	2.8	<1	110	17	30	13	3.5	1.1	2.3	0.36	25.97
		93L/16	96-SC- 16		sediment	4	7.5	590	4.2	2	13	120	3	4.2	5	2.0	31	1	17	3.6	2.1	<1	137	17	30	16	3.5	1.2	2.6	0.40	25.38
	3	93L/16	96-SC- 17		sediment	<2	8.9	670	<0.5	2	15	110	2	4.2	5	2.2	20	1.2	17	3.3	1.7	<1	154	16	31	14	3.4	1.2	2.4	0.39	29.82
		93L/16	96-SC- 18		sediment	<2	7.5	520	<0.5	2	13	120	2	4.0	4	2.1	40	1.2	15	3.4	2.0	<1	97	16	28	16	3.2	1.1	2.2	0.33	30.98
		93L/16	96-SC- 19		*moss mat*	<2	9.7	590	2.9	2	14	200	2	4.7	6	2.1	32	1.2	16	3.7	3.0	<1	80	17	33	12	3.4	1.1	2.5	0.40	30.95
	4	93L/16	997037		sediment	7	10.1	560	9.8	2	16	81	3	4.2	4	1.5	33	0.9	18	2.7	1.3	<1	140	15	28	18	3.5	1.1	2.4	0.29	29.27
Takla		93N/4	972001		sediment	3	9.9	570	2.2	1	13	260	1	3.2	3	1.4	22	1.6	11	2.1	1.3	<1	150	13	20	12	2.5	0.8	1.9	0.36	36.00
		93N/4	972002		sediment	5	11.0	530	2.8	<1	13	250	1	3.2	4	1.4	18	1.7	11	2.3	1.2	<1	139	14	22	11	2.6	0.9	2.0	0.35	33.62
		93N/4	972004		sediment	2	9.2	500	3.1	<1	12	250	1	3.0	3	1.3	16	1.5	10	1.9	1.4	<1	133	13	19	10	2.4	0.8	1.9	0.34	33.08
		93N/4	972005		*moss mat*	57	9.6	520	2.6	1	11	350	1	3.4	4	1.3	20	1.5	11	2.0	1.7	<1	103	14	21	12	2.5	0.8	2.0	0.38	32.65
		93N/4	972006		sediment	<2	2.3	150	3.4	4	23	390	<1	4.6	2	1.1	19	0.3	30	0.6	<0.5	<1	<50	6.2	11	7	1.8	0.7	1.6	0.24	36.63
		93N/4	972007		*moss mat*	<2	2.7	130	6.8	3	13	250	<1	3.0	2	0.8	<15	0.5	22	0.8	0.8	<1	<50	6.1	9	<5	1.7	0.6	1.4	0.24	25.13
		93N/4	972008		sediment	3	7.6	340	3.2	<1	17	180	1	3.6	2	1.2	30	1	17	1.5	0.8	<1	89	9.9	15	8	2.2	0.8	1.8	0.32	34.40
		93N/4	972009		sediment	<2	9.7	490	4.1	1	12	210	1	2.8	3	1.2	43	1.4	10	1.9	1.1	<1	149	13	19	9	2.5	0.8	1.9	0.33	32.12
Bivouac Ck.		93N/4	972101		*moss mat*	5	5.2	450	6.0	1	6	64	1	2.4	4	1.4	<15	0.9	11	2.3	1.2	<1	154	16	21	11	2.7	0.9	2.0	0.31	41.92
		93N/4	972102		sediment	<2	6.3	420	6.1	<1	8	58	2	2.5	3	1.3	29	0.9	10	2.2	1.1	<1	155	16	21	15	3.0	1.0	1.9	0.34	30.77
		93N/4	972103		*moss mat*	18	5.2	480	5.8	1	7	61	<1	2.3	4	1.3	21	0.9	10	2.1	1.2	<1	150	15	21	15	2.8	0.9	2.0	0.35	29.69
		93N/4	972104		sediment	<2	7.6	510	5.8	<1	8	53	1	2.5	3	1.3	24	0.9	11	2.2	1.0	<1	162	16	22	12	3.1	1.0	1.9	0.38	31.07
		93N/4	972105		*moss mat*	<2	5.8	480	4.5	1	7	67	2	2.5	4	1.4	30	0.9	10	2.3	1.2	<1	124	15	21	14	2.8	0.9	1.9	0.34	33.60
		93N/4	972106	10	sediment	<2	6.5	470	5.4	<1	8	66	1	2.5	4	1.3	29	1	10	2.3	1.6	<1	121	16	22	12	3.0	1.0	2.2	0.34	31.61
		93N/4	972107		*moss mat*	5	4.4	460	5.5	1	6	70	1	2.5	5	1.3	<15	0.9	11	2.3	1.1	<1	138	16	23	13	2.9	0.9	2.0	0.37	33.16
		93N/4	972108		sediment	<2	5.7	490	6.0	1	8	57	1	2.4	4	1.4	22	0.7	12	2.3	1.3	<1	216	17	20	15	3.4	1.2	2.3	0.42	34.27
		93N/4	972109		*moss mat*	<2	5.5	380	9.3	1	7	65	1	2.3	4	1.2	<15	0.6	11	2.2	1.0	<1	170	18	21	17	3.7	1.2	2.2	0.40	31.30
		93N/4	972111	20	sediment	<2	7.1	480	4.8	2	9	62	1	2.8	4	1.4	21	0.9	11	2.4	1.3	<1	181	17	25	15	3.2	1.0	2.2	0.38	28.64

TABLE 6. STREAM WATER GEOCHEMISTRY RESULTS

					RGS Suite and other determinations								ICP-MS Results								
Study Area		Map	ID		U ppb	pH	F ppb	SO4 ppm	Cond. uS	TDS mg/l	pH2*	T-Alk. ppm	Li ppb	Na ppb	Mg ppb	Al ppb	Si ppb	K ppb	Ca ppb	Sc ppb	Ti ppb
Granisle	1	93L/16	96-SCW-01		<0.05	8.2	36	9	230	114	7.4	-	0.9	2326.1	5127.5	12.7	6319	215	52138	5.28	1.02
		93L/16	96-SCW-02		<0.05	8.1	36	4	190.8	95.2	7.7	-	0.3	1765.4	3131.1	11.5	4067	189	37313	3.32	0.82
		93L/16	96-SCW-03		<0.05	8.1	34	3	189.2	94.6	7.8	-	<0.1	1743.2	3051.8	9.7	3908	191	37022	3.45	0.74
		93L/16	96-SCW-04		<0.05	8.1	34	4	191.2	95.6	7.7	-	<0.1	1742.0	3046.3	9.6	3889	194	36691	3.29	0.73
		93L/16	96-SCW-05		<0.05	8.1	32	4	192.4	96.2	7.7	-	0.2	1789.8	3161.7	9.1	4044	191	38827	3.40	0.82
		93L/16	96-SCW-06		<0.05	8.2	32	4	190.0	95.0	7.8	-	0.5	1772.7	3009.7	11.5	3884	164	37913	3.43	0.55
		93L/16	96-SCW-07		<0.05	8.3	34	12	238	119	7.4	-	0.4	1862.3	4066.8	9.7	5137	210	44113	4.48	0.87
		93L/16	96-SCW-08		<0.05	8.0	34	7	189.5	94.7	7.4	-	0.1	1790.8	3299.3	10.3	4467	163	36026	3.94	0.75
	2	93L/16	96-SCW-09		<0.05	8.3	44	14	255	128	7.6	-	0.2	2006.2	5264.5	8.3	5995	164	50313	5.53	0.95
		93L/16	96-SCW-10		<0.05	8.3	42	20	270	135	7.7	-	0.5	1904.4	5351.3	7.0	6039	169	51893	5.46	1.01
	3	93L/16	96-SCW-11		<0.05	8.3	44	9	245	122	7.7	-	0.3	3058.9	5669.6	11.4	5332	274	45452	4.84	0.69
		93L/16	96-SCW-12		<0.05	8.3	44	6	243	121	7.8	-	0.6	3098.8	5694.0	11.6	5391	270	45947	4.83	0.67
	4	93L/16	997037W		<0.05	8.0	42	8	211	106	-	-	-	-	-	-	-	-	-	-	-
			96-SCW-13	***Distilled water blank***[1]	-	-	-	-	-	-	-	-	*0.2*	*<0.8*	*8.8*	*<0.2*	*4*	*17*	*50*	*<0.02*	*<0.02*
			96-SCW-24	***Distilled water blank***[3]	-	-	-	-	-	-	-	-	*0.4*	*<0.8*	*<0.5*	*1.0*	*<1*	*<1*	*<1*	*0.04*	*<0.02*
Takla		93N/4	974002		0.9	8.2	110	44	490	245	-	232	3	3651	10168	<1	5172	721	86850	3	6.5
		93N/4	974003		<0.05	8.0	38	15	163.6	81.7	-	68	<1	1375	2483	11	3553	190	28664	2	1.6
		93N/4	974004		<0.05	8.1	40	15	163.8	81.8	-	68	<1	1402	2446	10	3515	183	27808	2	1.7
		93N/4	974005		<0.05	8.1	38	15	164.5	82.1	-	72	<1	1426	2559	12	3546	198	28197	2	1.9
		93N/4	974006		0.05	7.7	42	5	74.2	37.0	-	38	<1	1413	1550	14	2367	292	11703	1	0.6
		93N/4	974007		<0.05	8.2	64	13	244	122	-	120	<1	2112	2508	4	4131	191	45049	2	2.5
		93N/4	974008		<0.05	7.9	38	7	102.2	51.1	-	50	<1	1183	1265	12	3219	186	16951	2	1.0
		93N/4	974009		<0.05	8.0	42	16	166.7	83.3	-	72	<1	1348	2433	12	3388	182	28613	2	1.7
			974001	***Distilled water blank***[3]	*0.06*	*5.8*	*<20*	*1*	-	-	-	-	*<1*	*<20*	*<0.5*	*<1*	*<20*	*<10*	*<50*	*<1*	*<0.1*
			974011	***Distilled water blank***[4]	-	-	-	-	-	-	-	-	*<1*	*<20*	*0.6*	*<1*	*<20*	*<10*	*<50*	*<1*	*<0.1*
			974012	***Distilled water blank***[3]	-	-	-	-	-	-	-	-	*<1*	*<20*	*<0.5*	*<1*	*<20*	*<10*	*<50*	*<1*	*<0.1*
Bivouac Ck.		93N/4	974102		0.06	8.0	36	10	165.7	82.7	-	80	<1	1283	843	21	3586	201	30715	2	2.0
		93N/4	974103		<0.05	8.0	28	10	157.5	78.7	-	78	<1	1279	960	26	3612	216	27029	2	1.9
		93N/4	974104		<0.05	8.0	32	11	160.1	80.0	-	78	<1	1317	888	23	3489	207	30448	2	1.4
		93N/4	974105		<0.05	7.8	30	6	91.6	45.8	-	44	<1	1304	812	34	3627	148	16491	2	1.2
		93N/4	974106		<0.05	7.8	30	6	103.9	51.9	-	52	<1	1319	1342	30	2882	100	17396	1	1.1
		93N/4	974107		<0.05	7.8	32	7	110.0	54.9	-	54	<1	1305	913	24	3577	154	18833	2	1.3
			974101	***Distilled water blank***[3]	0.06	5.6	<20	1			-		<1	<20	<0.5	<1	<20	<10	<50	<1	<0.1
			974201	***Distilled water blank***[3]	<0.05	8.2	<20	<1	-	-	-	-	<1	<20	1.6	<1	<20	<10	<50	<1	<0.1
			974301	***Distilled water blank***[3]	<0.05	5.6	<20	<1	-	-	-	-	<1	24	<0.5	<1	<20	<10	<50	<1	<0.1
			974314	***Distilled water blank***[1]	-	-	-	-	-	-	-	-	<1	<20	<0.5	<1	<20	10	<50	<1	<0.1
			974315	***Distilled water blank***[3]	-	-	-	-	-	-	-	-	<1	<20	<0.5	<1	<20	<10	<50	<1	<0.1

** Corning pH meter*
[1] *Filtered, unacidified*
[2] *Filtered, acidified*
[3] *Unfiltered, unacidified*
[4] *Unfiltered, acidified*

Note: blanks in RGS suite (U, F, SO4, pH) are unfiltered/unacidified

TABLE 6. STREAM WATER GEOCHEMISTRY RESULTS

Study Area		Map	ID		V ppb	Cr ppb	Mn ppb	Fe ppb	Co ppb	Ni ppb	Cu ppb	Zn ppb	Ga ppb	Ge ppb	As ppb	Se ppb	Br ppb	Rb ppb	Sr ppb	Y ppb	Zr ppb
Granisle	1	93L/16	96-SCW-01		0.44	0.2	0.37	9.0	0.069	0.544	1.533	0.801	0.006	0.004	0.10	0.31	4	0.185	90.522	0.088	0.174
		93L/16	96-SCW-02		0.33	0.1	0.31	6.2	0.051	0.293	0.704	0.315	0.007	0.003	0.10	0.11	3	0.219	77.119	0.07	0.122
		93L/16	96-SCW-03		0.34	0.1	0.17	5.7	0.044	0.199	0.79	0.144	0.028	0.002	0.09	0.16	3	0.218	76.956	0.088	0.174
		93L/16	96-SCW-04		0.31	0.7	0.17	6.2	0.056	0.236	0.748	0.465	0.018	0.006	0.12	0.06	4	0.232	77.005	0.085	0.171
		93L/16	96-SCW-05		0.34	0.4	0.18	5.3	0.047	0.267	0.681	0.296	0.010	<0.002	0.11	0.26	4	0.228	78.813	0.083	0.093
		93L/16	96-SCW-06		0.31	0.6	0.27	4.1	0.052	0.294	0.664	1.618	0.014	0.010	0.08	0.19	3	0.215	77.035	0.075	0.100
		93L/16	96-SCW-07		0.34	0.6	0.32	6.0	0.065	0.312	1.135	0.351	0.017	<0.002	0.13	0.24	3	0.19	86.248	0.093	0.246
		93L/16	96-SCW-08		0.34	0.3	0.14	7.6	0.056	0.264	1.108	<0.002	0.015	0.009	0.07	<0.02	4	0.131	72.066	0.092	0.186
	2	93L/16	96-SCW-09		0.45	0.2	0.12	7.9	0.065	0.341	1.416	0.142	0.013	0.003	0.14	0.25	4	0.081	88.72	0.105	0.188
		93L/16	96-SCW-10		0.42	0.5	0.15	6.2	0.081	0.323	1.326	0.336	0.008	0.005	0.11	<0.02	4	0.095	89.715	0.088	0.163
	3	93L/16	96-SCW-11		0.31	0.2	0.20	6.6	0.063	0.330	0.66	0.201	0.006	0.008	0.14	<0.02	4	0.154	112.45	0.124	0.095
		93L/16	96-SCW-12		0.29	0.1	0.23	5.9	0.073	0.445	0.757	0.455	0.005	0.003	0.15	<0.02	4	0.154	110.82	0.119	0.122
	4	93L/16	997037W		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			96-SCW-13	***Distilled water blank*** [1]	*<0.02*	*<0.1*	*0.08*	*<0.2*	*<0.002*	*0.010*	*<0.002*	*0.133*	*<0.002*	*<0.002*	*<0.02*	*0.10*	*<1*	*0.006*	*0.32*	*<0.002*	*<0.002*
			96-SCW-24	***Distilled water blank*** [3]	*<0.02*	*<0.1*	*<0.02*	*2.3*	*<0.002*	*0.064*	*<0.002*	*0.187*	*<0.002*	*<0.002*	*<0.02*	*0.02*	*<1*	*0.01*	*0.191*	*0.006*	*0.007*
Takla		93N/4	974002		0.11	0.6	0.47	<3	0.109	0.65	<0.1	1.7	<0.01	<0.01	0.14	3.5	7	0.271	510	0.024	0.021
		93N/4	974003		0.23	<0.5	0.20	5	0.042	1.97	0.2	<0.5	<0.01	0.01	0.14	0.5	<3	0.098	158	0.068	0.021
		93N/4	974004		0.20	<0.5	0.20	3	0.052	1.71	0.1	<0.5	<0.01	<0.01	0.14	0.4	<3	0.101	154	0.069	0.02
		93N/4	974005		0.18	<0.5	0.16	4	0.036	1.94	0.1	0.7	<0.01	0.01	0.15	0.3	<3	0.092	151	0.068	0.021
		93N/4	974006		0.14	<0.5	0.24	17	0.020	0.51	0.4	<0.5	<0.01	<0.01	0.14	0.2	<3	0.225	43.1	0.118	0.050
		93N/4	974007		0.09	<0.5	0.06	<3	0.068	0.35	0.7	0.8	<0.01	0.01	0.11	0.2	5	0.175	156	0.040	0.020
		93N/4	974008		0.21	<0.5	0.12	<3	0.031	0.31	0.6	<0.5	<0.01	<0.01	0.12	0.3	<3	0.144	64.6	0.078	0.014
		93N/4	974009		0.14	<0.5	0.10	<3	0.041	1.40	<0.1	<0.5	<0.01	0.01	0.12	0.5	<3	0.099	155	0.068	0.022
			974001	***Distilled water blank*** [3]	*<0.05*	*<0.5*	*<0.05*	*<3*	*<0.005*	*<0.05*	*<0.1*	*<0.5*	*<0.01*	*<0.01*	*<0.03*	*<0.2*	*<3*	*<0.005*	*<0.02*	*<0.003*	*<0.005*
			974011	***Distilled water blank*** [4]	*<0.05*	*<0.5*	*<0.05*	*<3*	*<0.005*	*0.10*	*<0.1*	*<0.5*	*<0.01*	*<0.01*	*<0.03*	*<0.2*	*<3*	*<0.005*	*0.04*	*<0.003*	*<0.005*
			974012	***Distilled water blank*** [2]	*<0.05*	*<0.5*	*<0.05*	*<3*	*<0.005*	*0.07*	*<0.1*	*<0.5*	*<0.01*	*<0.01*	*<0.03*	*<0.2*	*<3*	*<0.005*	*0.02*	*<0.003*	*<0.005*
Bivouac Ck.		93N/4	974102		<0.05	<0.5	0.52	4	0.051	0.34	<0.1	<0.5	<0.01	<0.01	0.07	0.4	3	0.192	157	0.106	0.043
		93N/4	974103		0.06	<0.5	0.19	5	0.048	0.24	0.1	<0.5	<0.01	<0.01	0.12	0.6	<3	0.154	128	0.137	0.060
		93N/4	974104		<0.05	<0.5	0.48	7	0.048	0.34	0.2	<0.5	<0.01	<0.01	0.10	0.5	3	0.183	144	0.110	0.047
		93N/4	974105		0.05	<0.5	1.07	14	0.037	0.30	0.3	<0.5	<0.01	<0.01	0.09	0.2	3	0.197	76.1	0.187	0.085
		93N/4	974106		0.11	<0.5	1.01	41	0.033	0.21	0.2	<0.5	<0.01	<0.01	0.15	0.2	3	0.135	80.1	0.137	0.083
		93N/4	974107		0.09	<0.5	1.31	18	0.040	0.29	2.0	<0.5	<0.01	<0.01	0.13	0.5	4	0.181	90.6	0.148	0.067
			974101	***Distilled water blank*** [3]	<0.05	<0.5	<0.05	<3	<0.005	0.09	<0.1	<0.5	<0.01	<0.01	<0.03	<0.2	<3	<0.005	<0.02	<0.003	<0.005
			974201	***Distilled water blank*** [3]	<0.05	<0.5	<0.05	<3	<0.005	<0.05	<0.1	0.5	<0.01	<0.01	<0.03	<0.2	<3	<0.005	0.05	<0.003	0.006
			974301	***Distilled water blank*** [3]	<0.05	<0.5	<0.05	<3	<0.005	<0.05	<0.1	<0.5	<0.01	<0.01	<0.03	<0.2	<3	<0.005	<0.02	<0.003	<0.005
			974314	***Distilled water blank*** [1]	<0.05	<0.5	0.08	<3	<0.005	0.11	<0.1	<0.5	<0.01	<0.01	<0.03	<0.2	<3	<0.005	0.04	<0.003	0.012
			974315	***Distilled water blank*** [2]	<0.05	<0.5	<0.05	<3	<0.005	0.07	<0.1	<0.5	<0.01	<0.01	<0.03	<0.2	<3	<0.005	0.05	<0.003	<0.005

** Corning pH meter*
[1] *Filtered, unacidified*
[2] *Filtered, acidified*
[3] *Unfiltered, unacidified*
[4] *Unfiltered, acidified*

Note: blanks in RGS suite (U, F, SO4, pH) are unfiltered/unacidified

TABLE 6. STREAM WATER GEOCHEMISTRY RESULTS

Study Area		Map	ID		Nb ppb	Mo ppb	Cd ppb	In ppb	Sn ppb	Sb ppb	Te ppb	I ppb	Cs ppb	Ba ppb	La ppb	Ce ppb	Pr ppb	Nd ppb	Sm ppb	Eu ppb	Gd ppb
Granisle	1	93L/16	96-SCW-01		0.015	0.13	<0.002	0.002	0.097	0.02	<0.02	1.30	<0.002	17.607	0.034	0.045	0.011	0.054	0.008	0.009	0.006
		93L/16	96-SCW-02		0.016	0.12	<0.002	0.003	0.046	0.03	<0.02	1.24	<0.002	12.682	0.033	0.040	0.008	0.038	0.006	0.005	0.011
		93L/16	96-SCW-03		0.055	0.12	<0.002	0.007	0.049	0.03	<0.02	1.07	0.004	12.368	0.043	0.048	0.028	0.06	0.014	0.006	0.011
		93L/16	96-SCW-04		0.063	0.12	<0.002	0.004	0.051	0.03	<0.02	1.21	0.003	12.638	0.039	0.04	0.017	0.045	0.005	0.005	0.011
		93L/16	96-SCW-05		0.027	0.09	<0.002	<0.002	<0.002	<0.02	0.04	1.19	<0.002	13.262	0.028	0.027	0.014	0.034	0.010	0.006	0.010
		93L/16	96-SCW-06		0.031	0.08	0.015	<0.002	0.029	<0.02	<0.02	1.17	<0.002	12.678	0.031	0.029	0.011	0.034	0.007	0.005	0.010
		93L/16	96-SCW-07		0.031	0.09	<0.002	<0.002	0.028	<0.02	<0.02	1.21	0.003	15.434	0.039	0.036	0.015	0.047	0.011	0.007	0.012
		93L/16	96-SCW-08		0.045	0.12	<0.002	0.004	0.02	0.02	<0.02	1.41	0.003	12.150	0.036	0.021	0.012	0.056	0.012	0.007	0.014
	2	93L/16	96-SCW-09		0.044	0.15	<0.002	<0.002	0.006	<0.02	<0.02	1.10	<0.002	16.149	0.037	0.038	0.013	0.058	0.019	0.006	0.017
		93L/16	96-SCW-10		0.030	0.13	<0.002	0.002	<0.002	<0.02	<0.02	1.22	<0.002	16.298	0.028	0.031	0.010	0.037	0.014	0.008	0.010
	3	93L/16	96-SCW-11		0.012	0.17	<0.002	<0.002	0.008	<0.02	<0.02	1.34	<0.002	22.144	0.040	0.029	0.018	0.058	0.016	0.011	0.021
		93L/16	96-SCW-12		0.017	0.21	<0.002	<0.002	0.019	<0.02	<0.02	1.52	<0.002	21.659	0.045	0.028	0.012	0.052	0.017	0.011	0.019
	4	93L/16	997037W		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			96-SCW-13	***Distilled water blank***^{1}	*0.003*	*<0.02*	*<0.002*	*<0.002*	*<0.002*	*<0.02*	*<0.02*	*0.99*	*<0.002*	*0.145*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*
			96-SCW-24	***Distilled water blank***^{3}	*0.012*	*<0.02*	*<0.002*	*<0.002*	*<0.002*	*<0.02*	*<0.02*	*0.93*	*<0.002*	*0.140*	*<0.002*	*0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*
Takla		93N/4	974002		<0.005	4.73	0.04	<0.001	0.1	0.145	<0.2	2.1	0.012	41.00	0.015	0.027	0.006	0.009	0.002	0.004	0.001
		93N/4	974003		<0.005	0.49	0.01	<0.001	0.09	0.066	<0.2	2.2	<0.002	8.28	0.025	0.010	0.006	0.027	0.007	0.003	0.007
		93N/4	974004		<0.005	0.43	0.02	<0.001	0.05	0.066	<0.2	2.2	0.004	8.64	0.022	0.009	0.005	0.028	0.005	0.003	0.010
		93N/4	974005		<0.005	0.48	<0.01	<0.001	0.05	0.070	<0.2	2.3	<0.002	9.11	0.023	0.010	0.007	0.029	0.006	0.004	0.008
		93N/4	974006		<0.005	0.39	<0.01	<0.001	0.06	0.037	<0.2	2.5	<0.002	16.10	0.038	0.025	0.009	0.045	0.012	0.006	0.015
		93N/4	974007		<0.005	0.45	<0.01	<0.001	0.06	0.055	<0.2	2.4	<0.002	15.10	0.013	0.011	0.005	0.013	0.004	0.002	0.003
		93N/4	974008		<0.005	0.40	0.01	<0.001	<0.05	0.051	<0.2	2.2	0.009	6.30	0.021	0.007	0.005	0.027	0.006	0.002	0.008
		93N/4	974009		<0.005	0.50	0.01	<0.001	<0.05	0.066	<0.2	2.4	<0.002	8.32	0.021	0.007	0.006	0.026	0.007	0.004	0.008
			974001	***Distilled water blank***^{1}	*<0.005*	*<0.05*	*<0.01*	*<0.001*	*<0.05*	*0.007*	*<0.2*	*1.8*	*<0.002*	*<0.05*	*<0.005*	*<0.005*	*<0.002*	*<0.004*	*<0.001*	*<0.001*	*<0.001*
			974011	***Distilled water blank***^{4}	*<0.005*	*<0.05*	*0.03*	*<0.001*	*<0.05*	*0.007*	*<0.2*	*2.7*	*0.003*	*<0.05*	*<0.005*	*<0.005*	*<0.002*	*<0.004*	*<0.001*	*<0.001*	*<0.001*
			974012	***Distilled water blank***^{3}	*<0.005*	*<0.05*	*<0.01*	*<0.001*	*<0.05*	*0.007*	*<0.2*	*2.3*	*<0.002*	*<0.05*	*<0.005*	*<0.005*	*<0.002*	*<0.004*	*<0.001*	*<0.001*	*<0.001*
Bivouac Ck.		93N/4	974102		<0.005	0.72	0.03	<0.001	<0.05	0.060	<0.2	2.6	<0.002	13.20	0.039	0.020	0.011	0.050	0.010	0.006	0.014
		93N/4	974103		<0.005	0.82	0.03	<0.001	<0.05	0.053	<0.2	2.6	<0.002	15.00	0.051	0.024	0.016	0.059	0.015	0.007	0.019
		93N/4	974104		<0.005	0.77	0.03	<0.001	<0.05	0.050	<0.2	2.5	<0.002	14.00	0.044	0.019	0.014	0.060	0.008	0.006	0.015
		93N/4	974105		<0.005	0.38	0.03	<0.001	<0.05	0.053	<0.2	2.7	0.008	12.40	0.075	0.018	0.019	0.091	0.016	0.009	0.023
		93N/4	974106		<0.005	0.29	<0.01	<0.001	<0.05	0.033	<0.2	3.5	0.008	13.30	0.045	0.031	0.012	0.058	0.012	0.008	0.022
		93N/4	974107		<0.005	0.54	0.02	<0.001	0.08	0.052	<0.2	3.4	<0.002	13.50	0.054	0.025	0.015	0.071	0.023	0.006	0.018
			974101	***Distilled water blank***^{1}	<0.005	<0.05	<0.01	<0.001	<0.05	<0.005	<0.2	2.2	<0.002	<0.05	<0.005	<0.005	<0.002	<0.004	<0.001	<0.001	<0.001
			974201	***Distilled water blank***^{2}	<0.005	<0.05	<0.01	<0.001	<0.05	<0.005	<0.2	2.0	<0.002	<0.05	<0.005	<0.005	<0.002	<0.004	<0.001	<0.001	<0.001
			974301	***Distilled water blank***^{3}	<0.005	0.07	<0.01	<0.001	<0.05	<0.005	<0.2	2.1	0.031	<0.05	<0.005	<0.005	<0.002	<0.004	<0.001	<0.001	<0.001
			974314	***Distilled water blank***^{1}	<0.005	<0.05	<0.01	<0.001	<0.05	0.006	<0.2	1.9	<0.002	<0.05	<0.005	<0.005	<0.002	<0.004	<0.001	<0.001	<0.001
			974315	***Distilled water blank***^{2}	<0.005	<0.05	<0.01	<0.001	<0.05	<0.005	<0.2	1.9	<0.002	<0.05	<0.005	<0.005	<0.002	<0.004	<0.001	<0.001	<0.001

** Corning pH meter*
^{1} *Filtered, unacidified*
^{2} *Filtered, acidified*
^{3} *Unfiltered, unacidified*
^{4} *Unfiltered, acidified*

Note: blanks in RGS suite (U, F, SO4, pH) are unfiltered/unacidified

TABLE 6. STREAM WATER GEOCHEMISTRY RESULTS

Study Area		Map	ID		Tb ppb	Dy ppb	Ho ppb	Er ppb	Tm ppb	Yb ppb	Lu ppb	Hf ppb	Ta ppb	W ppb	Tl ppb	Pb ppb	Bi ppb	Th ppb	U ppb
Granisle	1	93L/16	96-SCW-01		0.005	0.011	0.003	0.009	<0.002	0.014	0.004	0.008	0.002	0.006	0.005	<0.02	0.028	0.058	0.020
		93L/16	96-SCW-02		0.005	0.009	0.003	0.006	<0.002	0.008	0.003	0.005	0.003	0.007	0.003	<0.02	0.018	0.029	0.011
		93L/16	96-SCW-03		0.015	0.009	<0.002	0.007	<0.002	0.019	0.015	0.006	<0.002	0.027	0.011	<0.02	0.025	0.107	0.021
		93L/16	96-SCW-04		0.012	0.008	0.003	0.005	<0.002	0.013	0.009	0.008	<0.002	0.022	0.008	<0.02	0.020	0.076	0.014
		93L/16	96-SCW-05		0.008	0.008	0.003	0.005	<0.002	0.011	0.006	0.004	0.002	0.011	0.002	<0.02	0.010	0.025	0.009
		93L/16	96-SCW-06		0.007	0.008	<0.002	0.006	<0.002	0.010	0.006	0.004	0.002	0.013	0.005	<0.02	0.013	0.027	0.010
		93L/16	96-SCW-07		0.007	0.011	0.004	0.007	<0.002	0.014	0.005	0.007	<0.002	0.009	0.004	<0.02	0.013	0.029	0.010
		93L/16	96-SCW-08		0.007	0.011	0.003	0.007	<0.002	0.013	0.006	0.007	0.003	0.015	0.005	<0.02	0.013	0.039	0.011
	2	93L/16	96-SCW-09		0.009	0.018	0.003	0.008	<0.002	0.015	0.006	0.003	0.003	0.017	<0.002	<0.02	0.014	0.038	0.030
		93L/16	96-SCW-10		0.006	0.014	<0.002	0.008	<0.002	0.009	0.005	0.005	<0.002	0.012	<0.002	<0.02	0.010	0.029	0.017
	3	93L/16	96-SCW-11		0.005	0.020	0.005	0.008	<0.002	0.010	0.003	0.004	<0.002	0.003	<0.002	<0.02	0.006	0.016	0.017
		93L/16	96-SCW-12		0.006	0.018	0.005	0.011	0.002	0.013	0.003	0.006	<0.002	0.003	<0.002	<0.02	0.006	0.016	0.030
	4	93L/16	997037W		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			96-SCW-13	***Distilled water blank***[1]	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.02*	*<0.002*	*<0.002*	*<0.002*
			96-SCW-24	***Distilled water blank***[2]	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.002*	*<0.02*	*<0.002*	*0.002*	*<0.002*
Takla		93N/4	974002		0.004	<0.001	<0.001	<0.001	<0.001	0.003	0.004	<0.002	<0.01	<0.01	<0.005	<0.1	0.019	0.008	0.042
		93N/4	974003		0.001	0.007	0.002	0.004	<0.001	0.004	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	0.012	0.004	0.016
		93N/4	974004		0.001	0.006	0.001	0.004	<0.001	0.002	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.002	0.009
		93N/4	974005		0.001	0.007	0.002	0.004	<0.001	0.003	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	0.011
		93N/4	974006		0.002	0.015	0.002	0.008	0.001	0.008	<0.001	0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.002	0.077
		93N/4	974007		0.001	0.005	0.001	0.002	<0.001	0.003	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.002	0.002
		93N/4	974008		<0.001	0.008	0.002	0.005	0.001	0.003	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	<0.001
		93N/4	974009		<0.001	0.007	0.001	0.003	<0.001	0.003	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	0.004
			974001	***Distilled water blank***[3]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.002*	*<0.01*	*<0.01*	*<0.005*	*<0.1*	*<0.005*	*<0.002*	*<0.001*
			974011	***Distilled water blank***[4]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.002*	*<0.01*	*<0.01*	*<0.005*	*<0.1*	*<0.005*	*<0.002*	*<0.001*
			974012	***Distilled water blank***[2]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.002*	*<0.01*	*<0.01*	*<0.005*	*<0.1*	*<0.005*	*<0.002*	*<0.001*
Bivouac Ck.		93N/4	974102		0.001	0.010	0.002	0.006	0.001	0.005	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.004	0.013
		93N/4	974103		0.003	0.010	0.003	0.009	0.001	0.009	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.004	0.023
		93N/4	974104		0.001	0.013	0.003	0.006	0.001	0.007	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.004	0.032
		93N/4	974105		0.003	0.023	0.004	0.011	0.002	0.011	<0.001	0.002	<0.01	<0.01	<0.005	<0.1	<0.005	0.007	0.013
		93N/4	974106		0.002	0.017	0.004	0.009	0.001	0.006	<0.001	0.003	<0.01	<0.01	<0.005	<0.1	<0.005	0.006	0.008
		93N/4	974107		0.002	0.017	0.003	0.008	0.002	0.008	<0.001	<0.002	<0.01	<0.01	<0.005	0.7	<0.005	0.005	0.017
			974101	***Distilled water blank***[3]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	<0.001
			974201	***Distilled water blank***[3]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	<0.001
			974301	***Distilled water blank***[3]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	<0.001
			974314	***Distilled water blank***[1]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.01	0.04	<0.005	<0.1	<0.005	<0.002	<0.001
			974315	***Distilled water blank***[2]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.01	<0.01	<0.005	<0.1	<0.005	<0.002	<0.001

** Corning pH meter*
[1] *Filtered, unacidified*
[2] *Filtered, acidified*
[3] *Unfiltered, unacidified*
[4] *Unfiltered, acidified*

Note: blanks in RGS suite (U, F, SO4, pH) are unfiltered/unacidified

TABLE 7. ROCK SAMPLE GEOCHEMISTRY RESULTS

ICP-AES Results: Rock Samples

Area	Lab No.	Sample	Stream	Mo	Cu	*Cu2*	Pb	*Pb2*	Zn	*Zn2*	Ag	*Ag2*	Ni	*Ni2*	Co	*Co2*	Mn	*Mn2*	Fe	*Fe2*	As	*As2*	Sr	Cd	*Cd2*	V	Ca	P	La
				ppm	ppm	*ppm*	ppm	*ppm*	ppm	*ppm*	ppm	*ppm*	ppm	*ppm*	ppm	*ppm*	ppm	*ppm*	%	*%*	ppm	*ppm*	ppm	ppm	*ppm*	ppm	%	%	ppm
				1	1	*1*	3	*2*	1	*2*	0.3	*0.2*	1	*1*	1	*1*	2	*5*	0.01	*0.01*	2	*2*	1	0.2	*0.5*	1	0.01	0.001	1
Granisle	52675	SJC 96-09	1	9	466	*467*	12	*8*	56	*60*	0.4	*0.6*	16	*11*	25	*24*	473	*580*	4.11	*4.23*	36	*42*	134	< .2	*<0.5*	108	3.44	0.096	3
	52676	SJC 96-10	1	< 1	73	-	6	-	66	-	< .3	-	9	-	7	-	709	-	3.26	-	< 2	-	28	< .2	-	58	0.95	0.081	9
	52677	SJC 96-11	1	3	113	-	13	-	28	-	< .3	-	9	-	6	-	234	-	2.77	-	20	-	27	< .2	-	21	0.35	0.094	19
	52678	SJC 96-12	1	1	74	*62*	12	*6*	357	*296*	< .3	*0.2*	82	*65*	37	*30*	1262	*1070*	5.95	*4.65*	< 2	*6*	79	0.7	*<0.5*	121	7.54	0.187	17
	52679	SJC 96-13	3	6	214	-	14	-	166	-	2.3	-	11	-	10	-	337	-	6.79	-	160	-	38	< .2	-	64	0.7	0.066	2
		SJC 96-13 repeat		6	208	-	11	-	164	-	2.2	-	10	-	10	-	320	-	6.68	-	160	-	37	0.2	-	61	0.66	0.065	2
	52697	SJC 96-32	1	3	87	-	7	-	76	-	0.3	-	25	-	29	-	478	-	4.26	-	35	-	150	0.4	-	125	2.37	0.104	2
Takla	53385	97-SC-01	1	1	22	*21*	68	*56*	83	*88*	< .3	*<0.2*	6	*5*	3	*3*	346	*350*	1.16	*1.17*	11	*6*	123	0.5	*<0.5*	32	1.55	0.033	4
	53386	97-SC-02	2	< 1	88	*83*	748	*590*	98	*94*	1.4	*1.6*	6	*4*	24	*23*	1223	*1225*	6.01	*6.17*	62	*58*	76	0.4	*<0.5*	108	2.54	0.073	1
	53387	97-SC-03	2	< 1	26	*19*	56	*38*	33	*34*	0.3	*0.2*	2291	*2120*	107	*90*	662	*615*	4.64	*4.37*	6	*10*	154	1.6	*<0.5*	27	0.55	0.003	< 1
	53388	97-SC-04	2	4	48	*71*	194	*206*	73	*136*	1.1	*0.8*	12	*25*	4	*4*	194	*225*	2.12	*2.51*	18	*<2*	17	0.5	*<0.5*	17	0.07	0.029	5
	53389	97-SC-05	2	2	7	-	15	-	54	-	< .3	-	9	-	3	-	258	-	0.95	-	3	-	99	0.5	-	14	1.56	0.021	10
	53390	97-SC-06	4	1	29	-	12	-	30	-	< .3	-	34	-	2	-	262	-	5.74	-	< 2	-	5	< .2	-	106	0.13	0.042	< 1
	53391	*97-SC-05 repeat*		2	8	-	45	-	64	-	< .3	-	5	-	3	-	237	-	0.87	-	7	-	87	0.5	-	13	1.4	0.021	10
	53392	97-SC-07	4	1	516	*591*	11	*10*	21	*26*	< .3	*0.2*	6	*6*	13	*15*	534	*600*	1.59	*1.83*	6	*<2*	35	0.5	*<0.5*	8	3	0.008	< 1
Bivouac	53393	97-SC-08	1	4	45	*44*	39	*38*	33	*30*	< .3	*<0.2*	3	*3*	2	*1*	201	*195*	1.26	*1.23*	6	*2*	14	< .2	*<0.5*	3	0.09	0.018	16
				CR*	-	*78*	-	*674*	-	*562*	-	*17.4*	-	*16*	-	*8*	-	*975*	-	*1.79*	-	*32*	-	-	*4.5*	-	-	-	-
				x ± 1s		*76 ± 9*		*690 ± 60*		*530 ± 64*		*17 ± 3*		*21 ± 5*		*8.6 ± 0.3*		*1010 ± 40*		*1.86 ± 0.06*		*25 ± 4*			*4.1 ± 0.7*				

Area	Lab No.	Sample	Stream	Cr	*Cr2*	Mg	*Mg2*	Ba	Ti	B	Al	Na	K	W	*S*	Sample Type	Description
				ppm	*ppm*	%	*%*	ppm	%	ppm	%	%	%	ppm	*%*		
				1	*1*	0.01	*0.01*	1	0.01	3	0.01	0.01	0.01	2	*0.01*		
Granisle	52675	SJC 96-9	1	14	*15*	0.65	*0.82*	72	0.13	< 3	3.8	0.71	0.13	< 2	*0.65*	stream boulder	green volcanic; pyrite, chalcopyrite, epidote
	52676	SJC 96-10	1	12	-	0.8		245	0.01	< 3	1.59	0.05	0.17	< 2	-	stream cobble	grey tuffaceous volcanic; pyritic
	52677	SJC 96-11	1	9	-	0.35		172	< .01	3	0.57	0.03	0.1	< 2	-	stream cobble	feldspar porphyry; pyritic
	52678	SJC 96-12	1	66	*69*	1.08	*0.91*	51	0.01	< 3	1.28	0.04	0.07	< 2	*1.68*	stream cobble	grey pyritic volcanic, with calcite veinlet
	52679	SJC 96-13	3	16	-	0.36		71	0.27	< 3	0.48	0.06	0.25	< 2	-	stream cobble	light green v.f.g. volcanic; limonitic, coarse pyrite
		SJC 96-13 repeat		17	-	0.34		86	0.26	< 3	0.46	0.05	0.25	< 2	-		
	52697	SJC 96-32	1	13	-	0.87		88	0.25	7	3.24	0.77	0.2	< 2	-	stream cobble	green tuffaceous (?) rock; pyrite, epidote
Takla	53385	97-SC-01	1	14	*13*	0.21	*0.22*	22	0.07	< 3	0.46	0.07	0.02	3	*0.01*	stream cobble	siliceous cobble
	53386	97-SC-02	2	10	*9*	1.52	*1.70*	68	0.14	3	2.57	0.21	0.11	< 2	*2.71*	stream cobble	grey volcanic with disseminated pyrite
	53387	97-SC-03	2	752	*711*	12.62	*12.65*	49	< .01	17	0.09	0.07	0.03	< 2	*0.39*	stream cobble	altered wehrlite (?); chloritic, silicified, with pyrite stringers
	53388	97-SC-04	2	10	*24*	0.28	*0.35*	101	< .01	3	0.59	0.02	0.23	< 2	*0.14*	stream cobble	limonitic slate
	53389	97-SC-05	2	12	-	0.28		24	< .01	< 3	0.33	0.08	0.02	2	-	stream cobble	quartz veining/stockwork
	53390	97-SC-06	4	148	-	1.61		39	0.24	< 3	1.45	0.04	0.06	< 2	-	stream cobble	limonitic chlorite-muscovite schist
	53391	*97-SC-05 repeat*		9	-	0.23		22	< .01	< 3	0.31	0.08	0.02	< 2	-		
	53392	97-SC-07	4	10	*11*	0.26	*0.32*	3	< .01	< 3	0.43	0.01	0.01	5	*0.74*	stream cobble	schist, with quartz, pyrite
Bivouac	53393	97-SC-08	1	11	*13*	0.12	*0.13*	157	0.01	< 3	0.59	0.05	0.23	4	*0.23*	stream cobble	silicified felsic volcanic with pyrite veinlet
				CR*	*23*	-	*0.47*	-	-	-	-	-	-	-	*0.03*		
				x ± 1s	*36 ±4*		*0.848±.090*								*313±28 ppm*		

Element determinations by aqua regia digestion/ICP-AES (Acme Analytical Laboratories)
Re-analyses of selected sample pulps by nitric-aqua regia digestion/ICP-AES (Chemex Labs)

CR*: USGS standard GXR-2 (in suite of re-analyzed samples)
(recommended values after Gladney and Roelandts, 1990)

TABLE 7. ROCK SAMPLE GEOCHEMISTRY RESULTS

INAA Results: Rock Samples

Area	Lab No.	Sample	Stream	Au	As	Ba	Ca	Co	Cr	Cs	Fe	Hf	Mo	Na	Ni	Rb	Sb	Sc	Ta	Th	U	W	Zn	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Mass
				ppb	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	g
				2	0.5	50	1	1	5	1	0.02	1	1	0.01	20	15	0.1	0.1	0.5	0.5	0.5	1	50	0.1	3	5	0.1	0.2	0.5	0.2	0.05	
Granisle	52675	SJC 96-09	1	27	64	660	6	28	27	<1	7.6	2	11	2.87	60	<15	13	23	<0.5	1.3	<0.5	<1	104	8.2	18	13	3	1.5	<0.5	2.3	0.35	36.80
	52676	SJC 96-10	1	12	1.8	1100	<1	5	25	3	3.5	3	3	2.72	<20	48	1.1	14	<0.5	2.6	0.9	<1	<50	16	28	13	3.3	1.3	<0.5	2.6	0.4	38.52
	52677	SJC 96-11	1	<2	26	1900	<1	5	18	1	2.64	5	4	3.76	<20	65	1	3.8	1.4	13	4.3	8	<50	42	64	27	4.7	1.5	<0.5	0.5	0.06	39.23
	52678	SJC 96-12	1	<2	4.3	180	5	34	110	<1	5.61	4	<1	5.3	<29	<15	0.3	23	<0.5	1.8	2	<1	368	19	40	17	4.5	1.7	<0.5	3	0.46	32.37
	52679	SJC 96-13	3	68	200	1500	4	11	46	<1	10.6	2	9	2.91	<24	54	8.6	16	<0.5	2.1	1.6	<1	189	19	31	14	2.4	0.8	<0.5	1.7	0.35	33.26
		SJC 96-13 repeat		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	52697	SJC 96-32	1	22	52	750	3	28	36	2	7.35	3	<1	3.64	<24	37	9.5	23	<0.5	1.6	1.6	<1	193	8.8	17	13	3.1	1.3	0.7	2.5	0.4	30.07
Takla	53385	97-SC-01	1	3	8.3	<50	4	4	16	<1	1.37	3	<1	4.03	<20	<15	0.6	6.9	1	2.2	1.6	2	100	13	21	17	2.1	0.9	<0.5	1.7	0.32	31.66
	53386	97-SC-02	2	<2	53	570	5	19	14	<1	6.22	3	6	2.23	<20	43	2.1	20	<0.5	1.9	<0.5	<1	112	9.9	20	9	3	1.3	0.8	2.6	0.43	33.62
	53387	97-SC-03	2	<2	5.4	80	<1	91	2600	4	5.05	<1	<1	0.11	1800	<15	0.7	9.8	<0.5	<0.2	<0.5	<1	84	0.6	4	<5	<0.1	<0.2	<0.5	<0.2	<0.05	31.46
	53388	97-SC-04	2	<2	18	600	<1	3	28	1	2.39	2	4	1.24	<20	47	2.7	9.3	<0.5	2	1.2	<1	<50	5.9	10	6	1.2	0.4	<0.5	1.5	0.25	32.55
	53389	97-SC-05	2	5	3.1	290	2	3	24	<1	1.02	3	5	5.58	<20	<15	0.6	3.5	<0.5	4.9	1.6	<1	<50	11	17	8	1.7	0.4	<0.5	2.2	0.32	36.98
	53390	97-SC-06	4	16	2	290	<1	<1	180	<1	6.44	1	<1	4.27	<20	<15	0.1	24	<0.5	0.5	<0.5	<1	<50	2.4	6	<5	0.7	<0.2	<0.5	0.9	0.15	33.44
	53391	*97-SC-05 repeat*		<2	5.9	<50	<1	3	13	<1	0.98	3	<1	5.85	<20	<15	0.9	3.6	<0.5	5.1	2.5	5	125	12	18	5	1.9	<0.2	<0.5	2.4	0.35	29.10
	53392	97-SC-07	4	<2	0.8	<50	3	13	13	<1	1.85	<1	<1	0.09	<20	<15	0.2	1	<0.5	0.2	<0.5	<1	<50	0.6	-3	<5	0.1	<0.2	<0.5	0.2	<0.05	30.94
Bivouac	53393	97-SC-08	1	3	0.7	2700	<1	2	11	<1	1.53	4	5	1.96	<20	73	0.8	1.7	<0.5	8.1	2.9	4	<50	22	31	9	1.5	0.5	<0.5	1.4	0.2	32.52

Element determinations by thermal instrumental neutron activation analysis (Activation Laboratories)

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